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THE WILD JOY OF A HORSE THAT IS FREE

THIS FINE PICTURE OF A COLT IS FROM THE PAINTING BY MISS LUCY KEMP-WELCH

The Everyday Library

For Young People

EDITED BY

ARTHUR MEE
Temple Chambers, London

HOLLAND THOMPSON, Ph. D.
College of the City of New York

Editors of the Book of Knowledge

Marvels of Industry

☆

THE WORLD'S WORK AND PROGRESS IN
SCIENCE, COMMERCE AND INDUSTRY

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Marvels of Industry

"The noble privilege to do
Is man's most glorious dower."

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COLOURED PLATE

The Wild Joy of a Horse That Is Free . . . . . Frontispiece

ROUND THE WORLD IN FIVE MINUTES

THE MOST AMAZING JOURNEY IN THE WORLD—THROUGH NEW LANDS AND OLD, THROUGH BARBARISM AND CIVILISATION, OVER CITIES AND MOUNTAINS, AND IN THE OCEAN DEPTHS

THE MARVELLOUS WAY A TELEGRAM GOES

Two men are sitting side by side by the shore of the Philippine Islands, and before them, on a table, are two instruments of curious design that continually write a straight line in ink on a roll of paper. Sometimes the line becomes wavy instead of straight, and the men have then to work alertly and quickly. The room in which they sit is the half-way communication house of the modern world.

Both their instruments are connected with London by a copper wire, but from one instrument the wire runs eastward across the Pacific Ocean, the continent of Northern America, and the Atlantic Ocean, to England, while the other wire dives into the Indian Ocean, curves up the coast of Africa, and passes through the Mediterranean Sea on its way to London. So that when these two wires are connected they entirely encircle the earth, and the two operators, sitting side by side in a little room at Manila, in the Philippines, can, by working quickly together, flash a message round the world in four or five minutes. They are in practical control of a combination of English and American cable systems that links all the scattered races of mankind together with the speed of lightning. Like the system of nerves in our bodies, transmitting the thoughts and feelings and impulses by which we live and move, the great telegraph lines branch out from the centres of civilisation to remote islands and distant countries, and carry over land and under seas a stream of information that governs the activities of nations and makes them parts of one vast whole—parts of a wonderful, world-wide civilisation.

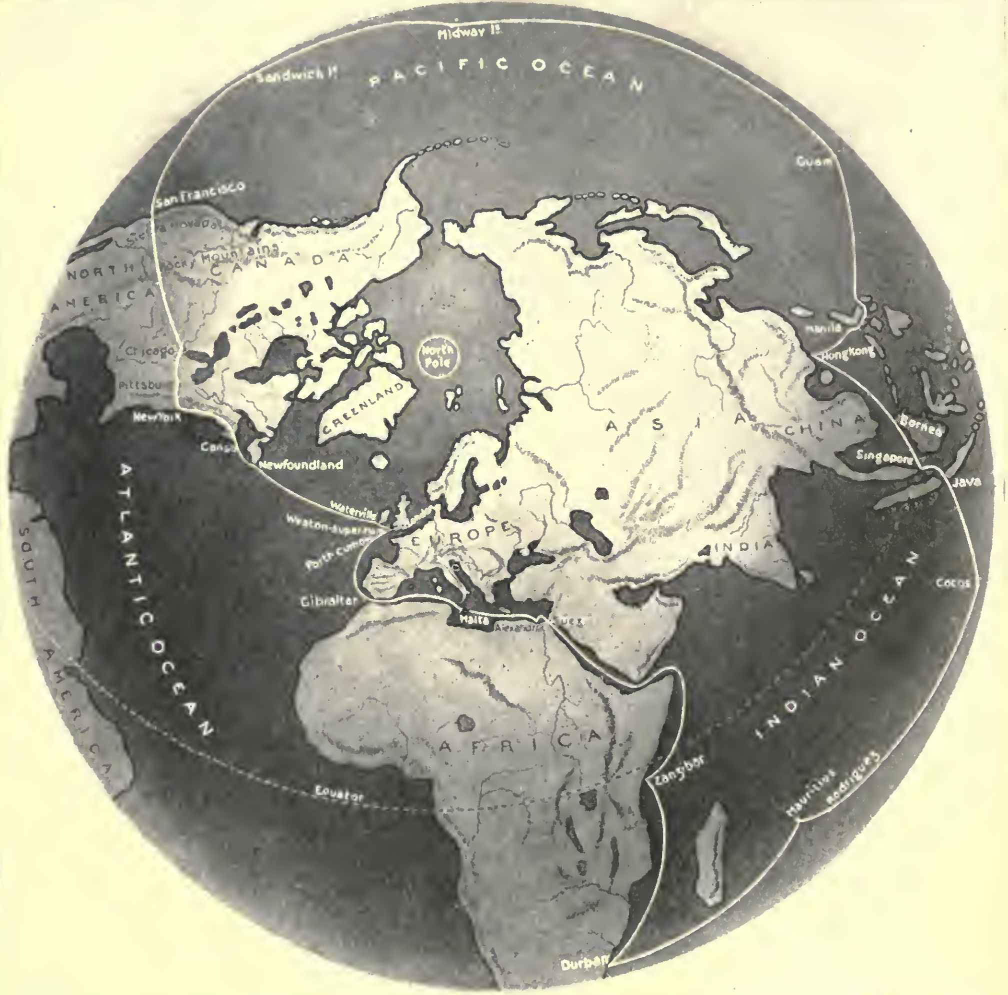
So swiftly does a message now run round the earth that, if the lines were kept clear, it would be almost quicker, in some business parts of London and New York, to telegraph to a friend a few streets away by means of the two operators sitting in the cable room in the Philippine Islands than to send a boy in a cab with the message. For example, there is a cable station belonging to the American Company at the Royal Exchange, London, opposite to the Bank of England, while the English Company have a branch station a little distance away at Mincing Lane. Let us send two messages from one office to the other; one shall be a cable message round the world, from the Royal Exchange to Mincing Lane; the other shall be a written message sent by a messenger boy in a taxi-cab.

We call at twelve o'clock, mid-day, and hand the cable message to the operator in the dim little room in the Royal Exchange. We are fortunate in finding that the line is clear, so that the cable can be sent straight away. This gives us an advantage over the messenger boy, for, after he has managed to hail a taxi at last, the cab has become blocked on its way to him by the thick, slow traffic between the Exchange and the Bank. The operator gives a few quick taps—some short and some long—with the sending key of his telegraph instrument. These taps represent the various letters of our message in what is known as the Morse system of telegraph signals. At each tap the electric current flowing along a copper wire is affected. Suppose our message to consist of the sentence, "Well done." This would be represented by a series of short and long taps, like these:

·—— · ·—·· ·—·· —·· ——— —·
w e l l d o n e

These short and long impulses of electricity set out on their voyage round the earth in less than a second after the operator strikes the key. They flow along the wire from the instrument into another wire that runs through the streets of London out into the open country to the west of the great city. The wire is carried on telegraph poles over the fields, woods, towns, and cities of the south of England, to the pleasant watering-place of Weston-super-Mare. It has taken less than a second to cover the 140 miles from London, and our rival, the messenger boy, is still waiting on the curb by the Royal Exchange for the taxi to come to him.

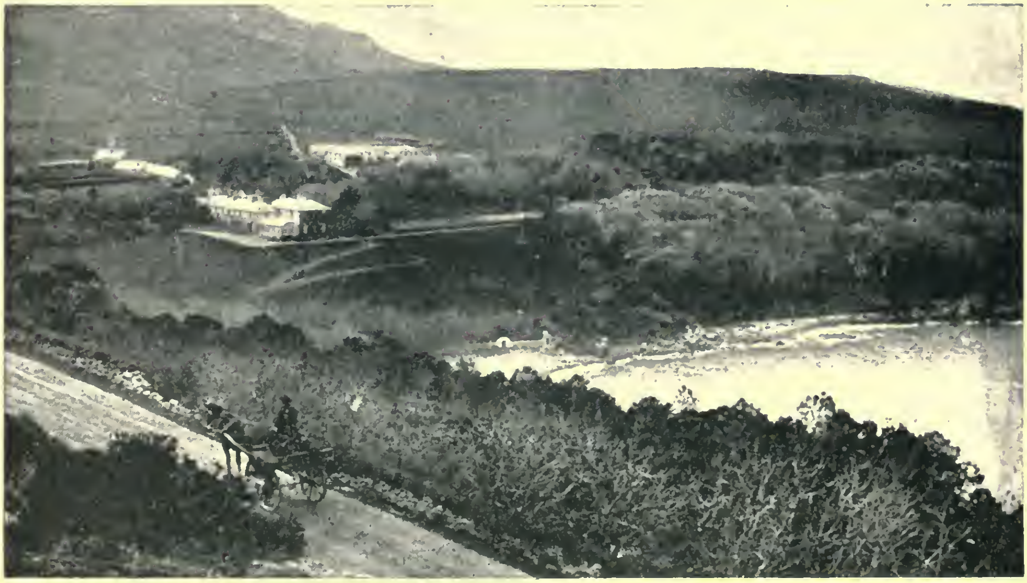
Unfortunately, the electrical current carrying our message has grown feeble in its lightning flash over the meadows and apple orchards of the West Country. Some years ago it would have been necessary for an operator to take the words down as they clicked into his receiving instrument, and to transmit them from another instrument again on the next stage of the journey. It would take a long time for our thought to travel round the globe if this re-transmitting had to be done very often. Happily, a new invention has recently made it possible to strengthen the electric message on its way from London to New York, so that it now makes the journey without interruption. As it comes feebly off the land wire at Weston-super-Mare, it enters an instrument where a current from another battery gives it new force. Speeding along with renewed energy, it flows into a wire covered with gutta percha and, plunging into the Bristol Channel, crawls along the sea-bottom to one of the wildest and loveliest spots in the British Isles—the little hamlet of Waterville, on the west coast of Kerry. It is not very far from the Lakes of Killarney.



THE JOURNEY OF A TELEGRAM ROUND THE WORLD—31,170 MILES

Down by the cable station, where our message is flowing into an instrument, and acquiring new strength from a local battery for the next stage of its travels, some Kerry fishermen are launching a boat to catch some mackerel. The women in blue cloaks

Noon. A telegram sets out from a little office near the Royal Exchange in London to travel round the world and back again, and dips into the sea by this pleasant beach at Weston-super-Mare. **146 miles**



5 Seconds. Into the Bristol Channel and under the Atlantic to Ireland the message runs, touching land again after 328 miles, emerging from the sea among the lovely hills of county Kerry. **474 miles**

20 Seconds. Its power increased with the new force picked up in Ireland, the telegram plunges down into the bed of the Atlantic, creeping through masses of sea creatures that are building up new mountains, until it passes under the fishing boats off the Grand Banks of Newfoundland. **2270 miles**

stand by, shading their eyes with their hands, watching the glittering school of fish leaping far out in the waters. It is a hard, hungry life these people lead between the mountain and the moors of Kerry, and the mackerel, if the fishermen get the net over them, will mean food and money. An old blue-coated man hobbles up, talking in Irish; he can hardly speak a word of English, though, no doubt, his sons and grandsons can. But we cannot listen to what he is saying; we must follow our message, which has taken scarcely a moment to flash along the 328 miles of cable from the English to the Irish coast, and has gathered strength for its great dive into the Atlantic depths. Down it goes into the great ocean, where the cable stretches beneath the seaweed, with black lobsters and big crabs groping over it as it swings in the grip of the tide. Deeper and deeper it goes into the calm, cold region of eternal darkness, where tide and storm and wind are unknown.

Like fields of enchanted corn, tall growths of curious plant-like animals, glowing with a beautiful radiance, hide the cable; and some of the smaller luminous forms of life attach themselves to the outer covering of the wire that carries our message. Strange fishes with bright lantern eyes dart by, and shining sharkish monsters sweep down in search of prey. There have been cases where the electric messages from continent to continent have been suddenly stopped by some big, fierce creature mistaking the cable for a conger eel, piercing it, and breaking the path of the current. If this happens, the cable must be brought up and repaired before any telegram can be sent along it.

Heavier and blacker grows the water around it as our message speeds through the Atlantic Ocean. Nearly all the radiant forms of sea life cease, and the cable runs at a depth of two miles below the waves, amid a grey mud formed of the crushed shells of tiny creatures that flourish and die and continually send their bodies in a fine, grey rain to the dark ocean floor. As the grey ooze which they make thickens and hardens, it becomes chalk, and in this way were formed the chalk hills of England millions of years ago.

40 Seconds. Now the message is 3000 miles on its way, having touched the wild coast of Nova Scotia at Cape Canso, and reached New York, the busiest city of the busiest continent on the earth. **3525 miles**

Passing south of the Grand Banks of Newfoundland, where fishermen from Brittany and the United States, from Great Britain and Portugal, and from Canada

60 Seconds. Through the great cities of the United States the message flies, over the high tops of New York, until it passes along these wires in the Rocky Mountains of Colorado. **5664 miles**

80 Seconds. Now at the Far West of America, the prosperous city of San Francisco, the telegram plunges into the depths of the Pacific Ocean near this beautiful Golden Gate, and thrills on its way under the sea for more than 2000 miles to Honolulu, the chief city of the Hawaiian Islands. **7428 miles**

and Newfoundland, come for the codfish, our telegram runs along the cable to the little fishing village of Canso, in the north of Nova Scotia. This part of Canada is wild and beautiful. The large-horned moose and the caribou roam the inland region, and there are 2000 Red Indians of the Micmac tribe, renowned for their skill in making bows and arrows. The white settlers are daring and gallant fishermen, and a few years ago they had more ships, in proportion to their numbers, than any other race in the world. Many of them, however, have now taken to a forest life, and get a living as lumbermen, cutting down the big trees and selling the wood, and clearing the land for farming. In one part of Nova Scotia a man can now ride in the spring-time for fifty miles under a canopy of pink and-white apple-blossoms.

It is 1796 miles from the shore of Kerry to the tall, bold cliffs of New Scotland—which is what Nova Scotia means—and the electric current has again grown feeble in passing over this great distance. So at Canso it is once more strengthened by a flow of electricity from a land battery through which it passes. Then away it goes, over the land wire, without stopping for retransmission. It crosses the neck of country connecting Nova Scotia with the mainland of Canada, and shoots through the primeval forest of New Brunswick, where steam-mills are now grinding the tall old spruce-firs into pulp for making paper. But there are still many large tracts of wild woodland and lonely lakes where the Red Indian and the wild deer are found.

Almost in a second our electric message has thrilled along the humming wire and passed into a land tamed by the white man. A mighty forest has been cut down, the soil has been parcelled out into small farms, and little farming

100 Seconds. Coming up in mid-ocean, the telegram emerges here, on the group of Hawaiian Islands, close by the house in Honolulu where Robert Louis Stevenson lived and wrote some of his beautiful children's verses. **9704 miles**

100 Seconds. The message flies past quaint little native houses such as these before it dips into the sea again. **9704 miles**

120 Seconds. At this stage of its journey, after about [illegible] miles from Honolulu, the message is at the little sand patch in the Pacific known as Midway Island. **11,036 miles**

villages have swiftly grown into busy industrial cities, so full of people that the country around can hardly provide them with food. New England has become like old England. Our message has entered the United States.

When the Trans-Pacific cable was laid from San Francisco to Manila, President Roosevelt sent a message around the world in nine minutes. If it had been possible to link up all the connections automatically, it would have taken no longer to send that message around the world than to send it from London to Weston-super-Mare. No matter what the distance from one station to the next, the actual time of transmission is the same—that is to say, it takes no longer to send a message from San Francisco to Honolulu, a distance of 2276 miles, than from London to Weston-super-Mare, a distance of 146 miles. The greater part of the time taken to send a message around the world is consumed by receiving and transmitting at the various stations.

150 Seconds. From Midway Island, a dark journey of 4237 miles along the ocean bed brings the message to the half way house around the world, and at the end of 150 seconds the telegram is at Manila, where it finds little men of the East like these busily working and playing. **15,273 miles**

Our message has not taken a minute to flash from London to New York. Indeed, scarcely has the operator in the Royal Exchange removed his finger from the sending key than the rat-tat-tat of our message sounds in the telegraph office of the chief city of the United States, and our rival, the boy messenger, is only opening the door-handle of his taxi-cab, which has at last reached the curb opposite the Bank of England. But, though the cable system has a good start of him, having covered the 3525 miles of wire between London and New York in the twinkling of an eye, we must now lose a little time, for our message has to be retransmitted. The operator of the Commercial Cable Company takes it down as it comes over the wire, and hands it to a man working beside him, who is in charge of one of the Postal Company's instruments. It takes but a few seconds to send the message clicking across the United States, and while this is being done we have just time to catch a glimpse of the skyscrapers of New York City—the highest buildings in the world, going up to the clouds like cliffs or mountain pinnacles, and leaving the streets like ravines, full of gloom and thronged with white-faced, nervous, bustling business men.

In these great cities of America the noise and whirl and hurry are dazing to a strange visitor. Trains run under the streets and above the streets, and street cars jangle to their stopping-places, where struggling crowds push and hustle to find seating room. A feverish energy animates New York; it is one of the greatest seaports in the world, and the greater part of the wonderful trade of the United States with foreign countries passes through it.

But our message is not here long; it is on its way again to Pittsburg, the Birmingham of the New World, with vast coal-fields around it, and petroleum refineries, and iron and steel foundries, and innumerable factories smoking to the grey skies above the far-stretched streets. From

Pittsburg the electric impulses thrill without a stop to Chicago, built on a marsh by the edge of Lake Michigan. In the childhood of men still living this immense and mighty city was a lonely Indian trading fort, on the trail from the lakes to the Mississippi. Now it is the second largest centre of commerce in America. More railways meet there than anywhere else on the earth. Chicago was really built out of wheat. It stood between the rich wheatfields of the Middle West and the prosperous manufacturing cities of New England and the Middle Atlantic States, from whose ports the wheat was shipped to Europe. So, as the wheatfields and cattle farms developed, Chicago grew larger and wealthier, and the rapid growth of its power and size was one of the wonders of modern civilisation. It is said that the meat-packers of Chicago still control the price of beef in both the United States and Europe, and that a few men meeting in Chicago are able to decide what shall be paid each day for meat. A few years ago the price of flour and bread was also decided by Chicago, but, with the opening up of new wheat districts in Canada, and the exhaustion of some American wheatlands, the Chicago people have lost much of their power over the wheat markets of the world.

150 Seconds. Fine types of girls are busy at work as the message crosses the Philippine Islands. **15,273 miles**

Strengthened by joining a local current in Chicago, our message flows without interruption farther west to the big, muddy Missouri River, and, crossing the turbid waters, arrives at the city of Omaha, in Nebraska. Most of the Nebraskans are farmers, and as the climate is warm they grow large quantities of corn and fatten animals on it. Omaha distributes their produce; a dry season means hard times, and a good harvest brings wealth to the city. It was the people of Nebraska who originated the happy custom of appointing the festival of Arbor Day for the planting of trees on the tenth of April in every year. This festival has been celebrated for almost half a century by many school children in England as well as in our own country, and the result is that many waste lands are being covered with forests, which help the farmers by keeping moisture in the soil, and afford an abundant supply of cheap timber wood.

Over the plains of ripening corn runs the wire that is carrying our message, and then the telegram stops for a fraction of a second at the foot of the wild Rocky Mountains. Here the city of Denver has sprung up at the spot where the stage-coach used to change horses on the overland route to the West. Denver is the centre of mining operations, and from here supplies are forwarded to the men digging out silver and gold and lead in the neighbouring heights. Our message speeds up the Rocky Mountains, and, climbing another range of heights at Ogden, above the Great Salt Lake, it crosses a vast rolling desert of granite peaks and waterless valleys known as the Great Basin.

150 Seconds. The natives of Manila, emerging from barbaric life under the new sway of their white rulers from the United States, are busy preparing their feasts as the message flashes by. **15,273 miles**

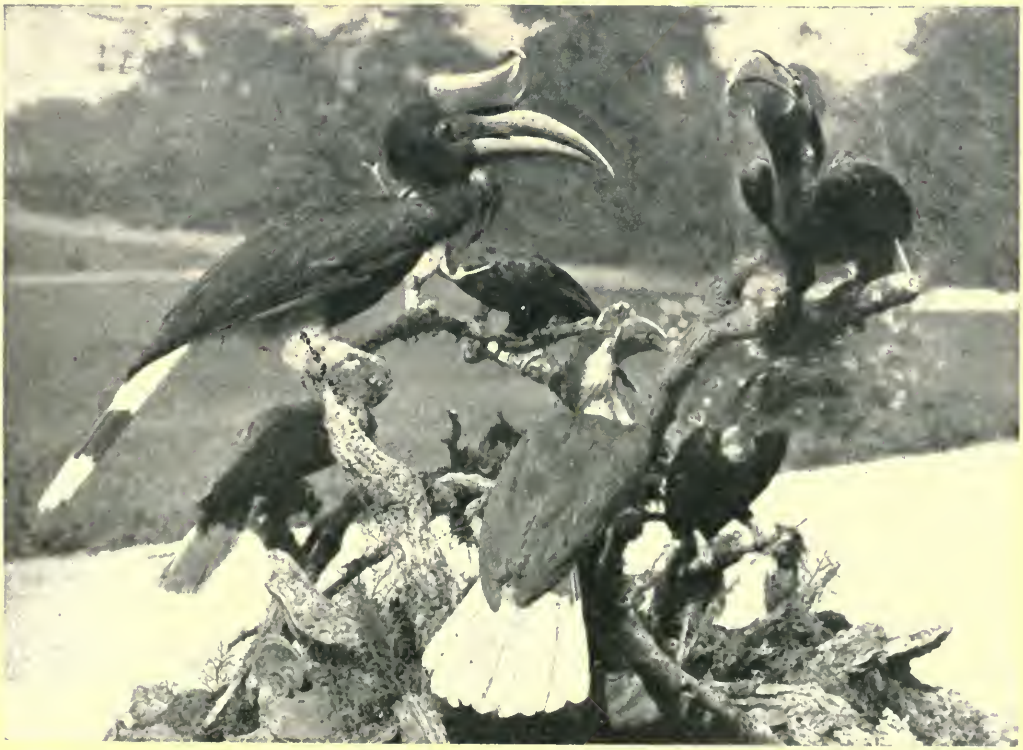
170 Seconds. Now the telegram touches China, emerging from the sea at Hong Kong, a British corner of the Chinese Empire, and flies past many lovely Chinese gardens such as this. **16,010 miles**

Then, running through a pass in the wild heights of Sierra Nevada, the message enters the lovely and fertile country of California, and soon clicks out in the telegraph office in San Francisco. It has made a journey of 3903 miles from New York without a break, picking up fresh current as it flowed through the great towns along its route. Yet it is still not much more than a single minute since our telegram left London, and it has travelled by land and sea for over 7000 miles, while our taxi is slowly creeping on its way through the crowded London street.

170 Seconds. By the great gateways and towers of old China, where civilisation reached a high plane thousands of years ago, the telegram flashes before it plunges once more beneath the waters. **16,010 miles**

But there is now a little delay, as the telegram has to be taken back from the Postal Company's wire and despatched over the cable belonging to the Commercial Pacific Company. Here, however, as at New York, the re-transmission is quickly performed, the receiving operator and the sending operator sitting side by side, their instruments before them, and working swiftly together. Plunging into the depths of the Pacific Ocean, the message thrills along the submarine line for 2276 miles, and comes up close to a house in the wild and lovely Hawaiian Islands, where Robert

180 Seconds. Then southward to Borneo and Brunei, in Malaysia, the message reaches the home of these picturesque little people, the land of curious savages and fierce warlike tribes. **17,247 miles**



180 Seconds. The telegram flies unseen past the queer Hornbills that fly about in Sarawak. **17,247 miles**

Louis Stevenson lived, writing the poems and stories we all love so well. On one of these islands the most terrible volcano in the world forms a great lake of fire, with dancing pillars of flame, and it was here that Captain Cook was murdered by savages after he had sailed round the world. But the people have now passed out of barbarism, and have become peaceful citizens of the United States. Gay and light of heart, they live amid the palms and ferns and bread-fruit trees of their wonderfully fertile valleys, looking charming as they stroll along with flowers in their hair and between their lips or behind their ears. Their chief town, Honolulu, has grown into an important seaport, and many Chinamen and Japanese have come to live in this paradise of the Southern Seas.

Very different is the next place at which our message stops for a fraction of time. For 1332 miles it flashes under the waves to the bare little Sand Island at Midway. A few years ago this tiny group of coral islands was a bleak patch of sand, inhabitated by wild birds of the ocean—frigate birds, albatrosses, and smaller kinds. Now grass has been planted to bind the sand together, and white men play golf there to while away the time between their spells of work at the cable station. But they must be careful to look where they hit the golf ball, for the island is very small and low, and the balls are often lost in the ocean. Close by is an island smaller still, where Japanese poachers come to steal and kill beautiful wild birds for the sake of their plumage—a crime that the United States is doing its best to stop.

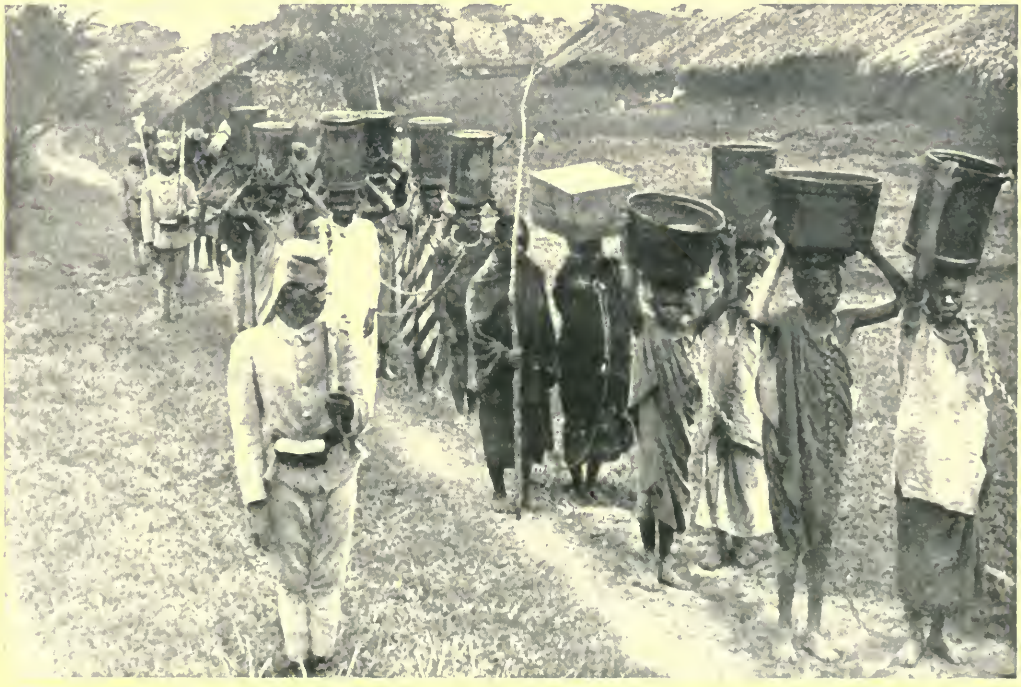
180 Seconds. Still in Malaysia, the telegram touches the coast guarded by this lighthouse. **17,247 miles**

From Sand Island, in the tiny Midway Group, the cable bearing our lightning message runs far below the sunlit ocean to the Islands of the Thieves. This is rather a disagreeable name for the people inhabiting the place, but it does not sound so bad in the original Spanish—the Ladrones. It was the first inhabited land Magellan touched when he sailed, first of all white men, into the Pacific Ocean, in his great adventure of proving that the world was round by voyaging round it. The natives of the islands stole so many things from his ships that he gave them the bad name that has stuck to them ever since. They speak a curious language known as Chamoro, and most of them still live in little bamboo houses. Chairs are unknown, and a mat spread on the floor serves as a bed. The women cook the meals in mud hearths, and go to the nearest hillside to cut wood as they want it.

The people are kind, and generous, and peaceful, but they were terribly ill-treated at times by their Spanish conquerors. Guam, the largest of the Ladrone Islands, and the one through which our telegram passes, now belongs to the United States, and the Americans are trying to help the islanders to improve their ways of life. They are still inclined to steal, but this is largely because of their poverty. Fierce hurricanes sweep in from the sea, and a part of the land is composed of volcanic rock. Deep in the heart of the earth, the central fiery energy still works in these parts, producing slight earthquakes at times.

From Midway to Guam our message has covered 2606 miles, and it has another 1631 miles to go through the dark abyss of the sea before it reaches the half-way house round the world, at Manila, in the Philippine Islands. But this it does in the twinkling of an eye. So marvellously quick has the electric current been, in spite of the time taken in re-transmitting our message at various points, that it has passed over England and Ireland, through the Atlantic

200 Seconds. Having found new strength in Labuan, the telegram speeds 736 miles more to the city of Singapore, and from this fine harbour it is again sent out on its way. From Singapore to Java, the island made prosperous by the Dutch, the message rushes on, and then to the Indian Ocean, past Cocos Island and Mauritius, past the island of Madagascar, to Durban and Zanzibar. **24,048 miles**



230 Seconds. The strange life of a half-civilised people echoes in its path at Zanzibar, and from such scenes as this, in which chained prisoners are led by Arab soldiers, the message travels thousands of miles round the East Coast of Africa, through the Red Sea, to the Suez Canal. **27,395 miles**

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Ocean, over North America, and under the Pacific in less than two and a half minutes, covering half-way round the world while our rival, the messenger boy, is emerging in his taxi-cab from the block of vehicles near Mincing Lane. So we have leisure to peep at the sights and people of Manila while the operator of the Commercial Pacific Company is handing our telegram across the table to the operator of the Eastern Extension Telegraph Company.

The greater number of the Filipinos are of Malay origin, but on the wooded mountains are tribes of wild, naked savages who are among the lowest races of mankind. They are small in body, and it is said they still practise head-hunting with poisoned arrows, and cannibalism. Most of the Filipinos, however, are peaceful farmers, cultivating their rice fields and sugar plantations, and their beautiful tropical land is one of the richest in the world. The people are rather lazy, and a great deal of the trade and shopkeeping is carried on by Chinamen, who have settled in large numbers in some of the islands. There are also Arabs and Malays, who follow Arabian customs and religion. All this gives a very picturesque variety to the life and scenes of Manila, the older part of which is walled round. Some of the modern streets look like those of Chicago though the buildings are kept low, because earthquakes occur that would topple a tall edifice down to the ground. It is strange to think that in this same island black pigmies are running wild in forests, using bones and flints to fight their enemies; and that stronger tribes of fierce head-hunters live here who are still more dangerous. But since the United States has taken control of the islands the work of civilising the people has been proceeding apace.

250 Seconds. At Suez the telegram makes its way through the narrow pass of water made by man, the Suez Canal, with one bank in Egypt and the other in Arabia, to Alexandria. **27,634 miles**

From Manila our message runs under the sea to China. A steamer takes two and a half days to cover the 737 miles, but the electric current makes the journey in a few seconds, emerging at Hong Kong. Not many years ago Hong Kong was a barren mass of granite, thinly inhabited by poor fishermen, but since it became British it has grown to be one of the great marts of the Eastern world, with splendid quays, dockyards, and arsenals, and its wide bay is crowded with Chinese junks and ships of all nations. Living by commerce with China and Japan, Hong Kong attracts many strange races together—Chinese, Hindus, Burmese, Malays, South Sea Islanders, Europeans, and Americans. So overcrowded is it that a multitude of Chinamen save house-rent by living in boats on the water; but they run great risks in the summer, when whirling hurricanes sweep in from the sea and scatter the ships.

From Hong Kong the cable bears our message southward to Borneo, a land of curious savages and warlike Malays. The savages are a shy, dwarfish race, living in unexplored parts of the tropical forest, and using poisoned darts, which they blow through long bamboo canes. Then there is a stronger, taller race, known as Dyaks, cruel and bloodthirsty; and on the coast live the picturesque and more civilised Malays. One of the great Malay towns lies near the little island of Labuan, through which our message goes. It is Brunei, or Borneo, and the Sultan lives there. Scarcely any ground is to be seen in this strange city, for all the houses are built on wood pile in a lake-like expanse of the river. In the main streets large vessels lie at anchor; in the market-place each shop is a canoe, occupied by a native woman wearing a large leaf hat of enormous size. Some of the natives row about with no clothes on, but most of the women wear gay-coloured petticoats.

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260 Seconds. In the ancient streets of Alexandria the great power of the modern world flashes past monuments which Pharaoh may have seen. **27,634 miles**

At Labuan, 1237 miles from Hong Kong, our message passes through an instrument which introduces a fresh current of electricity, and, thus strengthened, the telegram speeds another 736 miles to the island city of Singapore. This was an uninhabited rock when Great Britain took it over; now it is the capital of the Straits Settlements, and the busiest and wealthiest centre of commerce in Southern Asia. It is the point at which meet and cross the trade routes between India, China, and Japan, and the Dutch East Indies and Australia. Chinese come here in great numbers, and far outnumber the native Malays, the Hindus, and the white traders. John Chinaman is, in fact, the general workman and servant of the island city, and it is partly through seeing our ways of government at Singapore and Hong Kong that he has cut off his pigtail and set about reforming his own country.

Southward again from Singapore our telegram is despatched under the sea to the long island of Java, where the Dutchmen have made a canal through a flat river marsh and built a town, with neat porches and white-pillared entrances draped in rich tropical foliage. A range of volcanoes overlooks the city, and in one terrific eruption the houses and pleasant gardens were swept away. In the old town the Malays and Chinese dwell by the canals, but the European settlers live around a common two miles away. The broad roads are bordered with trees that meet overhead, and form arches of green shadows, and the low houses are surrounded with gardens full of fruit-trees, palms, and flowering shrubs. The mixture of races is even greater than at Singapore, and from all the islands come traders in quaint native boats, with the merchandise of the tropics. The Dutch have done a splendid work for mankind in training the native Malays in modern methods of farming, and in making them industrious.

For hundreds of years the Hindus ruled over Java, until they were conquered by Arabian invaders in 1478. They have left many beautiful monuments, now overgrown by the forests. Some of them are as striking in their way as the Great Pyramid of ancient Egypt.

From Batavia our message is sent by an automatic electric instrument to a group of coral islands in the Indian Ocean—the Cocos Islands, which lift their graceful plumes of palms above the foaming waves. This is only a journey of 778 miles, but then comes a long voyage under the sea to South Africa—a distance of 4272 miles. On the way the cable touches a wild little beauty spot of the British Empire—the island of Rodrigues, formed of the mountain-top of a tall volcanic peak springing from the darkness and silence of the ocean-bed. At the surface the island is only a few miles in extent, but it is extremely striking in appearance. It is a chaos of irregular masses of lava, cleft in places into mighty basaltic columns. A coral reef encircles this volcanic ruin, and the channels are so narrow that vessels reach the island only with difficulty. So lonely and wild was it that none of the early wandering races of mankind ever discovered and peopled it, and the first settler was a French Protestant who was driven from France because of his religion. His name was François Leguat, and he came to Rodrigues in a Dutch ship in 1691, staying for two years. He found immense numbers of tortoises, which, like the turtle, were good eating; and for a hundred years the French in a neighbouring colony used these as their meat supply. Rodrigues has now passed into British possession, and the fertile soil of the old volcano is turned into vegetable gardens and maize-fields. Many of the present settlers are descendants of the old French emigrants, and the coloured labourers brought over to help in catching tortoises have also helped to people the island.

270 Seconds. On to Malta, the fortified harbour which holds the key of British power in the Mediterranean, the cable has come 900 miles from Alexandria, and it leaves the island in less time than it would take a man to climb this famous street. **28,534 miles**

Four hundred miles across the ocean is another tropical island of volcanic origin. It is Mauritius, and, as our message comes for a moment ashore at Port Louis, we must just glance at its beautiful scenery. It was here that was written the famous story of "Paul and Virginie," which for the first time gave European readers a glowing picture of the splendours of tropical life. Gleaming between the woods are the white houses of the Europeans, who are mainly of French descent, and further up are the huts of the Madagascar natives, whose forefathers worked as slaves on the sugar plantations, with negroes from Africa. Beyond the huts are groves of strange trees and the misty tops of the inland mountains. Beside the Malagasy people, with their tall, strong forms and chocolate-coloured faces, the traveller meets in the streets Hindu coolies, working as porters, and Chinamen with smiling yellow faces and narrow, bright

280 Seconds. Our telegram is nearing home when it enters the British fortress of Gibraltar, the mighty rock which guards the entrance to the land-locked sea dividing Africa from Europe. **29,651 miles**

300 Seconds. And as the clock ticks away the three hundredth second, the telegram is back in England touching the picturesque coast of Porthcurnow. From this wild corner of Cornwall it is flashed to Mincing Lane, near the Royal Exchange, where it started. In five minutes it has been around the world, passed from one day into another, and back again into the same day on which it left London. **31,170 miles**

eyes. After the island was taken by the British in 1810 in the wars with Napoleon, it became an important calling-place for ships on their way to India.

Our telegram does not stop at Mauritius, but speeds along a cable there to Durban, in Natal. This seaport was developed by the discovery of gold-mines in the interior, and in the South African War it was a busy and tragic place. But now it has recovered its smiling prosperity of peace, and swarthy Zulus and other African tribesmen, picturesque Hindus, and British and Dutch settlers, throng its streets. It lies on a rich, warm coast, where maize and tea and fine fruit is grown; and from the cooler uplands of the interior come sheep and cattle in increasing numbers. About a hundred years ago the warlike Zulus threatened to sweep both the white men and the black natives out of the country. One of their leaders was as great a man in his way as Napoleon; but the white man has conquered, and the Zulu has been compelled to take to the peaceful work of farming.

Though the Portuguese entered on the task of founding colonies long before the English, having indeed been the first Europeans to round the Cape and discover the sea-road to the Indies, their African town of Mozambique, through which our message passes now, is not so well developed a centre of commerce as Durban and Cape Town. It lies on an island off the tropical coast, and was for centuries the resort of ivory-hunters and slave-traders. Big game, such as lions and hippotamuses, haunt the river-courses and jungles, but the land is now being cultivated by the blacks, and the island town is visited by Arabian merchants and Hindu traders.

Somewhat similar in situation is the other island town of Zanzibar, higher up the coast of Africa, at which our telegram stays for an instant to be re-transmitted. The Arabs have been long established at Zanzibar, where one of their warlike sultans reigned over the surrounding country, and enslaved and sold the African natives. But the British Government now rules over the ancient Arabian colony, and the negroes are fairly treated, and encouraged to work peacefully and freely.

From Zanzibar our message sweeps round the coast of Africa for nearly 2,000 miles, to the little British stronghold of Aden, guarding the entrance to the Red Sea, and protecting the ships on the way to India and the Far East. Through the Red Sea the cable goes for another 1402 miles to Suez, at the southern opening of the famous canal connecting the Mediterranean and the Indian Ocean. In spite of its position close to one of the greatest engineering feats of all time, Suez remains a wretched Arab town, reached by scarcely a ripple of modern civilisation. For the sea is receding from it, and a new port has had to be built two miles to the south at Tewfik.

At Suez the cable ends, and our message is sent on its journey by a wire stretching across the sands and ruins and irrigated fields of Egypt to the seaport of Alexandria. Here Egyptians, Greeks, Italians, and the motley races of the Levant, carry on a busy trade. Gone are all the glories of the ancient city built by Alexander, once the centre of learning and civilisation; but the city still remains one of the big bazaars of Oriental Africa. It stands partly on a vast causeway constructed by one of the Pharaohs, and from this causeway our message now dives once more into the sea, speeding to the island of Malta, nine hundred miles beyond.

Malta is one of the places in the Mediterranean which Great Britain made into a fortified harbour in the old days when her soldiers were fighting for their lives against the French, who are now her friends. The people of Malta are of Italian race—at least, in their language; but in origin they are a mixture of many peoples.

From Malta the cable runs to the most famous of all the strong possessions of the British Empire—the mighty Rock of Gibraltar, controlling with its guns the passage from the Atlantic Ocean to the Mediterranean. It is a little bit of Spain, which the Spanish lost by helping the French people to make war upon England. The armies of the two nations assailed a little band of British soldiers who held Gibraltar, and the siege lasted from June, 1779, to February, 1783. But the Rock was impregnable, and so powerful are the guns now, 1300 feet above the sea, that Gibraltar can stop any fleet in the world. Enormous stores of food are kept in cold rooms excavated in the heart of the Rock.

From Gibraltar our message takes its last flight under the waves, and, after a voyage of 1190 miles, it arrives at Porthcurnow, in Cornwall, whence it is flashed to London. It has travelled 31,170 miles round the earth, and is back in Mincing Lane. It is five minutes past noon, and as the message comes ticking into the office a knock comes at the door. It is our messenger boy, and the taxi is waiting.

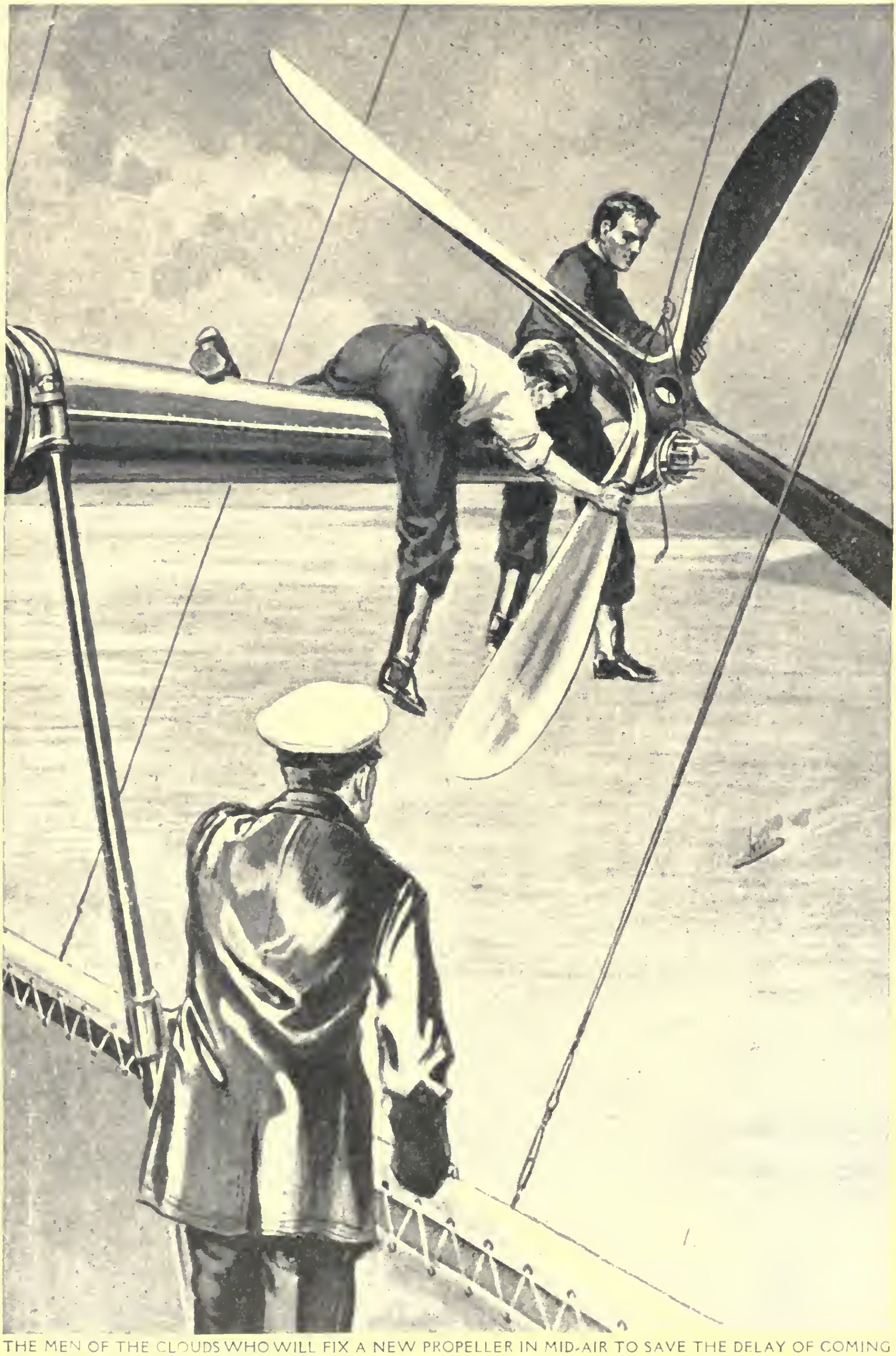
THREE WONDERS OF THESE DAYS

The Aeroplane · The Airship · The Submarine

THE RIDERS IN THE CLOUDS AND THE RIDERS IN THE SEA

THE MAN-BIRDS—A FRENCH BIPLANE CHASES A GERMAN TAUBE

THE INDOMITABLE SPIRIT THAT KNOWS NO FEAR

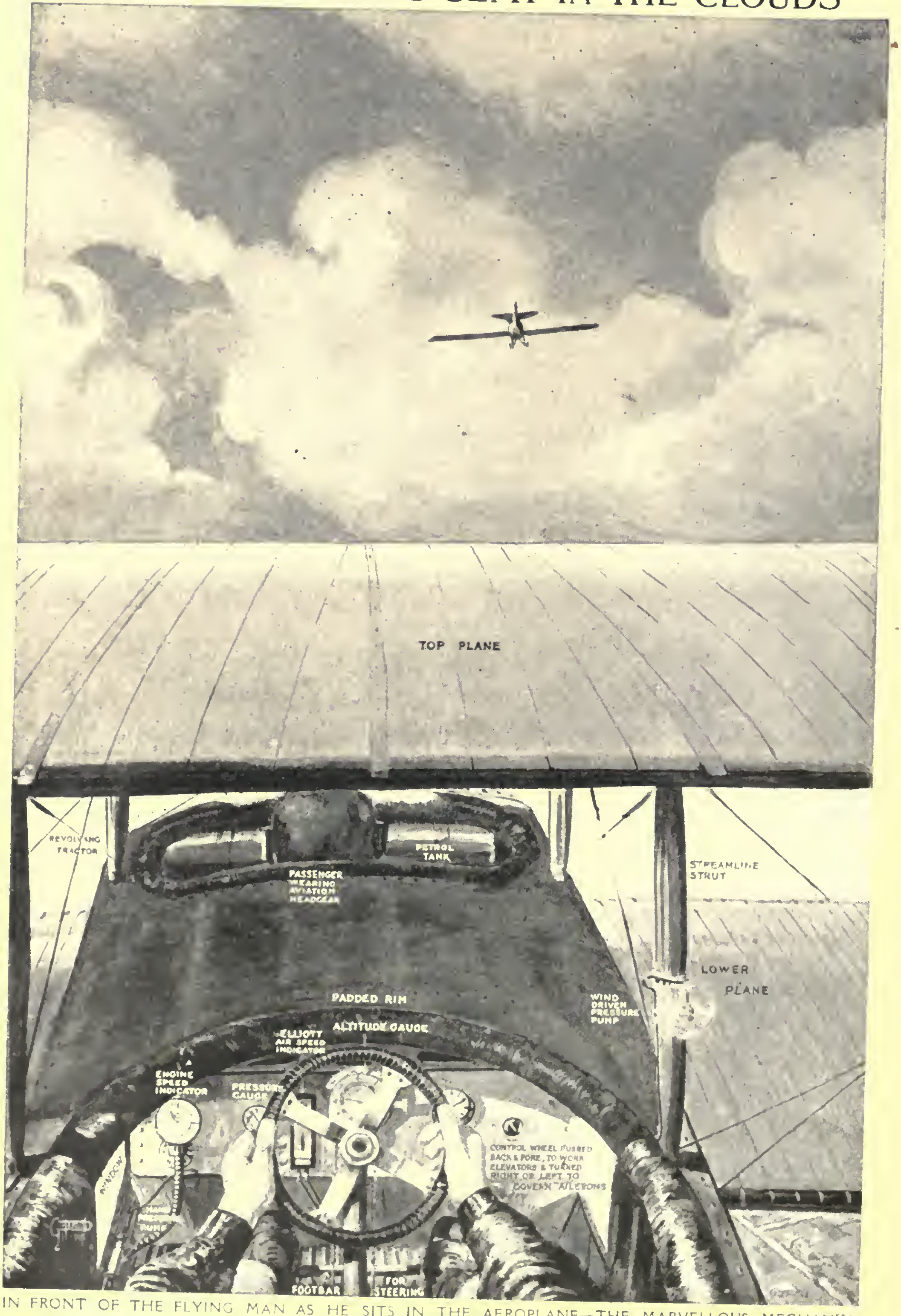


THE MEN OF THE CLOUDS WHO WILL FIX A NEW PROPELLER IN MID-AIR TO SAVE THE DELAY OF COMING DOWN IN A CRITICAL HOUR FOR THEIR COUNTRY This occurred on a British seaplane 2000 feet above the North Sea

THE MAN-BIRDS SWOOP DOWN TOWARDS EARTH

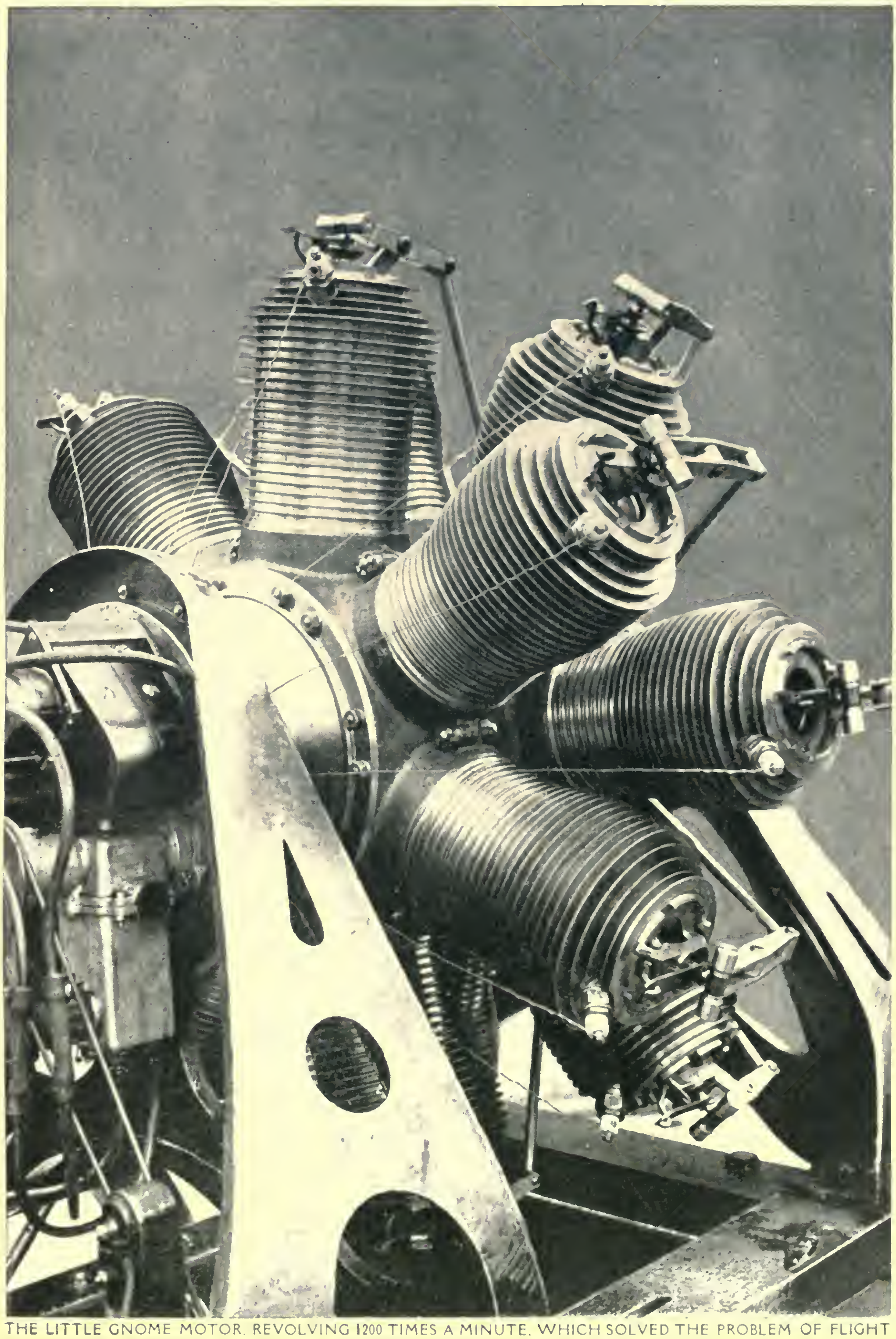
AN AEROPLANE MAKES A DIVE

THE FLYING MAN'S SEAT IN THE CLOUDS


TOP PLANE
REVOLVING TRACTOR
PETROL TANK
PASSENGER WEARING AVIATION HEADGEAR
STREAMLINE STRUT
LOWER PLANE
PADDED RIM
WIND DRIVEN PRESSURE PUMP
ALTITUDE GAUGE
ELLIOTT AIR SPEED INDICATOR
ENGINE SPEED INDICATOR
PRESSURE GAUGE
CONTROL WHEEL PUSHED BACK & FORE, TO WORK ELEVATORS & TURNED RIGHT OR LEFT TO GOVERN AILERONS
WINDOW
FOOTBAR FOR STEERING

IN FRONT OF THE FLYING MAN AS HE SITS IN THE AEROPLANE—THE MARVELLOUS MECHANISM CONTROLLING THE FASTEST MOVING MACHINE ON EARTH

THE ENGINE THAT RIDES AMONG THE EAGLES



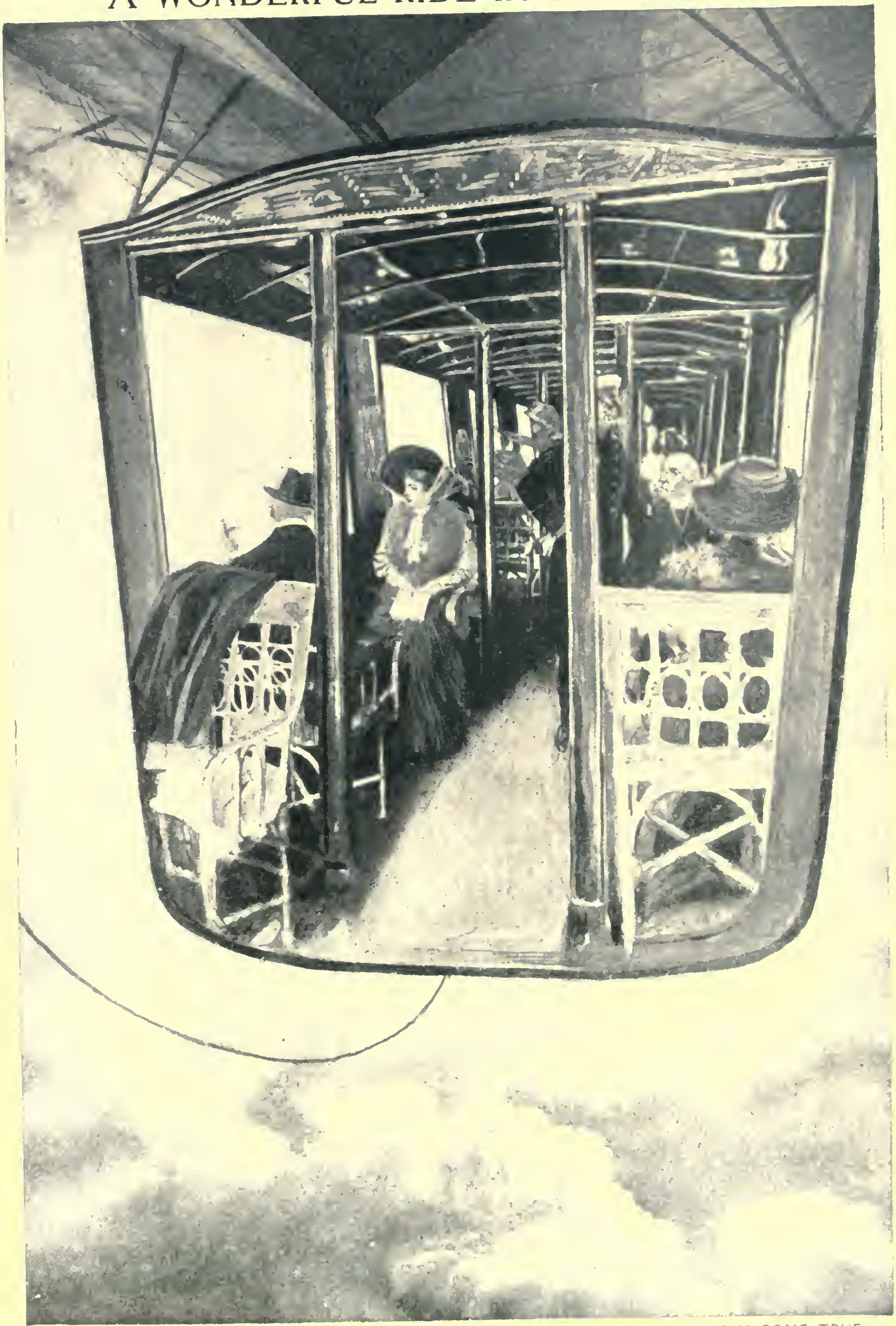
THE LITTLE GNOME MOTOR, REVOLVING 1200 TIMES A MINUTE, WHICH SOLVED THE PROBLEM OF FLIGHT FOR MEN, AND IS STILL THE DRIVING FORCE OF MOST AEROPLANES

THE NEW WAY OF SEEING THE WORLD

THE ZEPPELIN IS WONDERFUL TO SEE RIDING IN THE CLOUDS

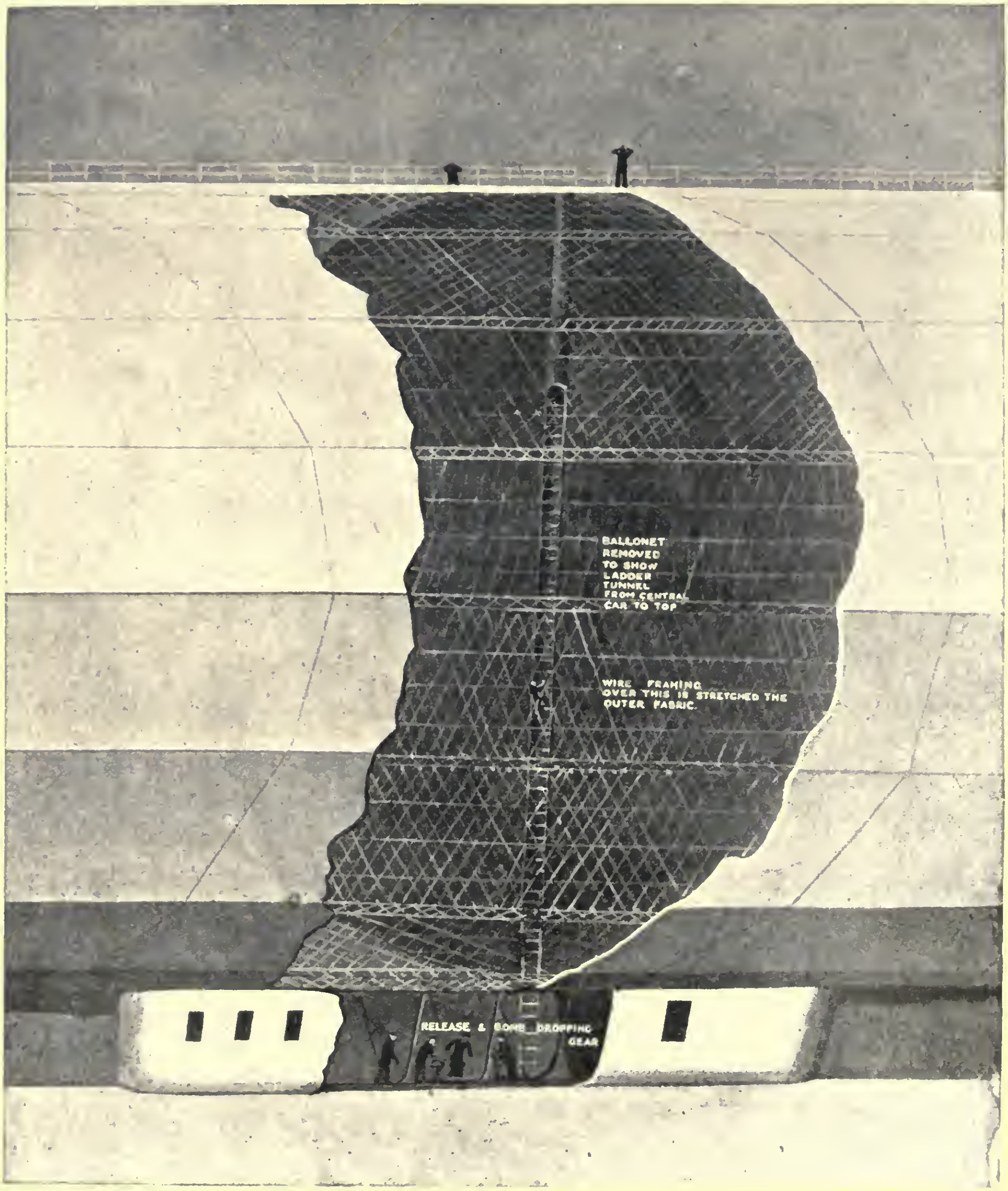
From The London Sphere, through the N. Y. Herald.

A WONDERFUL RIDE IN THE CLOUDS

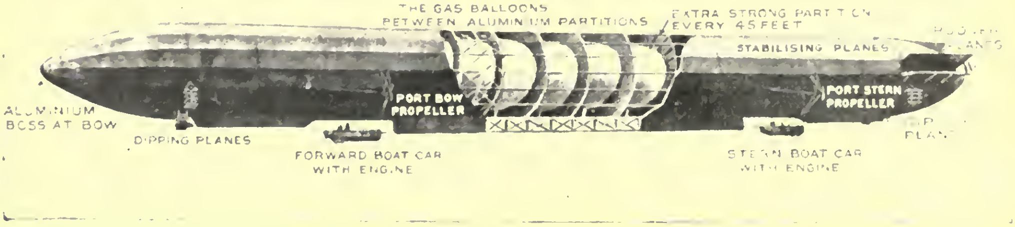


A THING THAT SEEMED IMPOSSIBLE WHEN WE WERE BORN, WHICH HAS NOW COME TRUE

CLIMBING UP TO THE GALLERY OF AN AIRSHIP


BALLONET REMOVED TO SHOW LADDER TUNNEL FROM CENTRAL CAR TO TOP
WIRE FRAMING OVER THIS IS STRETCHED THE OUTER FABRIC.
RELEASE & BOMB DROPPING GEAR

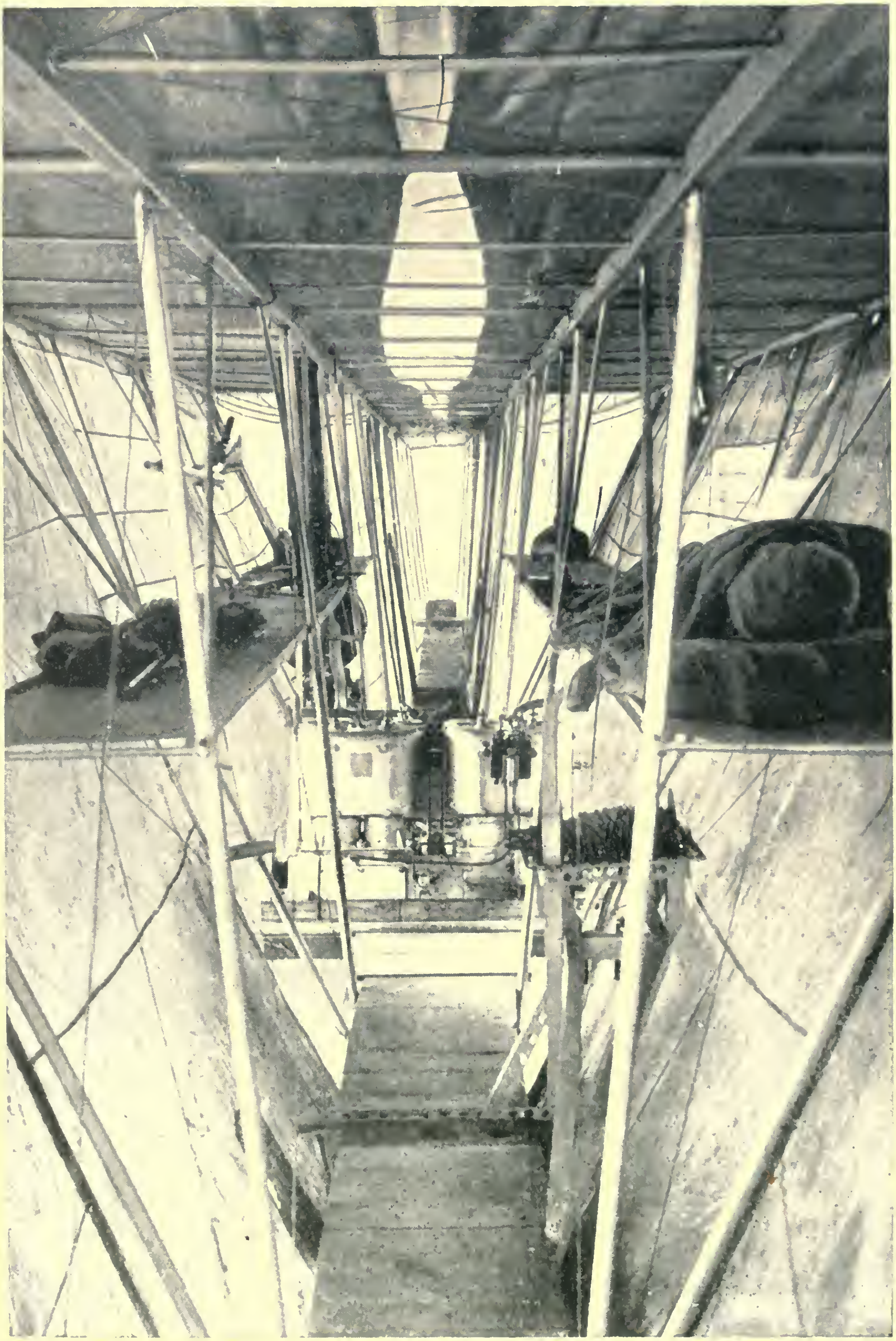
THE TUBE LEADING FROM THE CAR OF A ZEPPELIN TO THE OBSERVATION GALLERY ALONG THE TOP
THE ALUMINIUM ENVELOPE IS TORN OPEN TO SHOW THE STEEL FRAMEWORK AND THE PARTITION


THE GAS BALLOONS BETWEEN ALUMINIUM PARTITIONS
EXTRA STRONG PARTITION EVERY 45 FEET
RUDDER PLANES
STABILISING PLANES
ALUMINIUM BOSS AT BOW
PORT BOW PROPELLER
PORT STERN PROPELLER
DIPPING PLANES
DIP PLANES
FORWARD BOAT CAR WITH ENGINE
STERN BOAT CAR WITH ENGINE

A ZEPPELIN OVER 500 FEET LONG LIKE A THREE-STOREY HOUSE SUPPORTED BY 17 GAS BALLOONS
CONTAINING A MILLION CUBIC FEET OF GAS

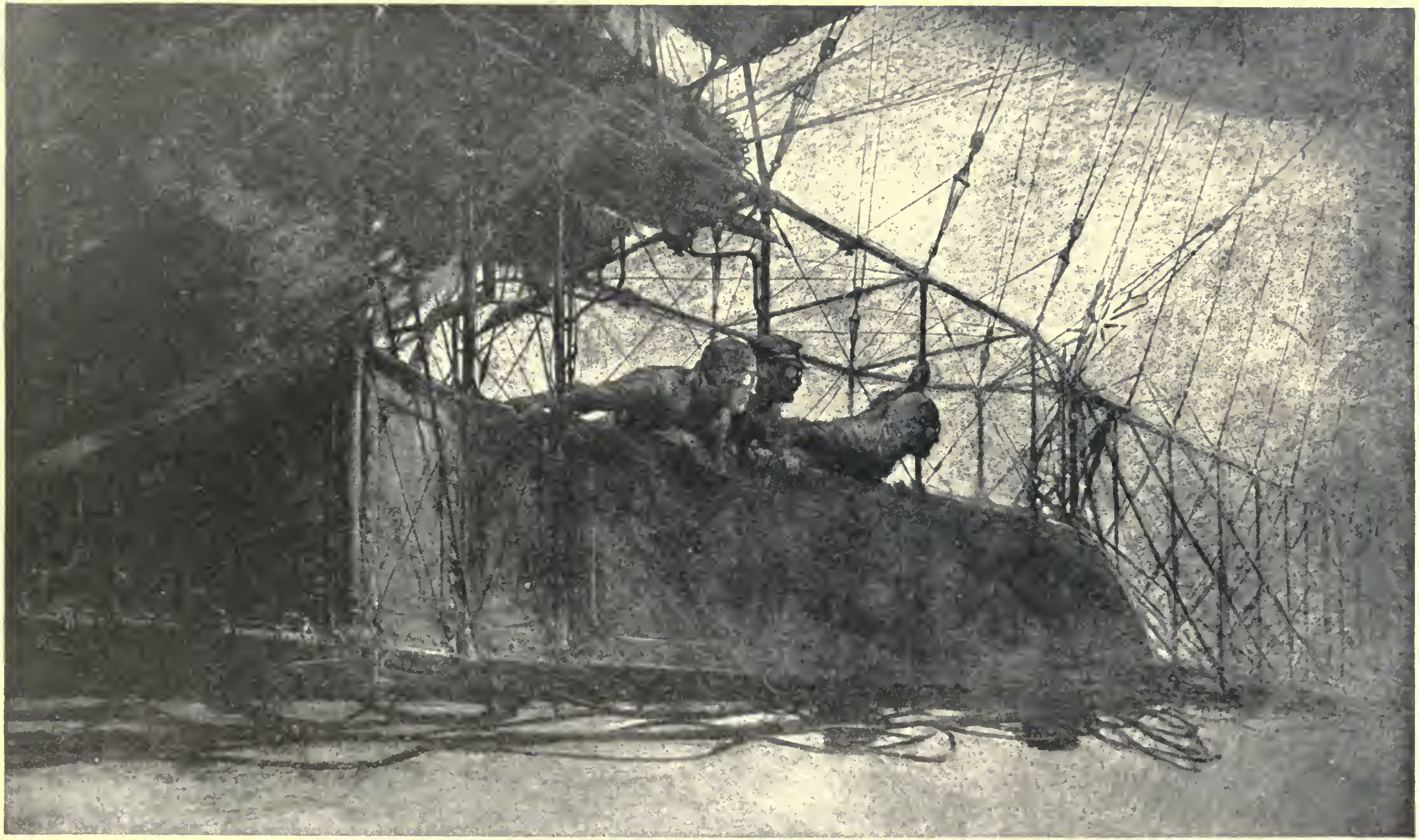
From The London Sphere, through the N. Y. Herald.

A SLEEPER ABOVE THE BUSY WORLD



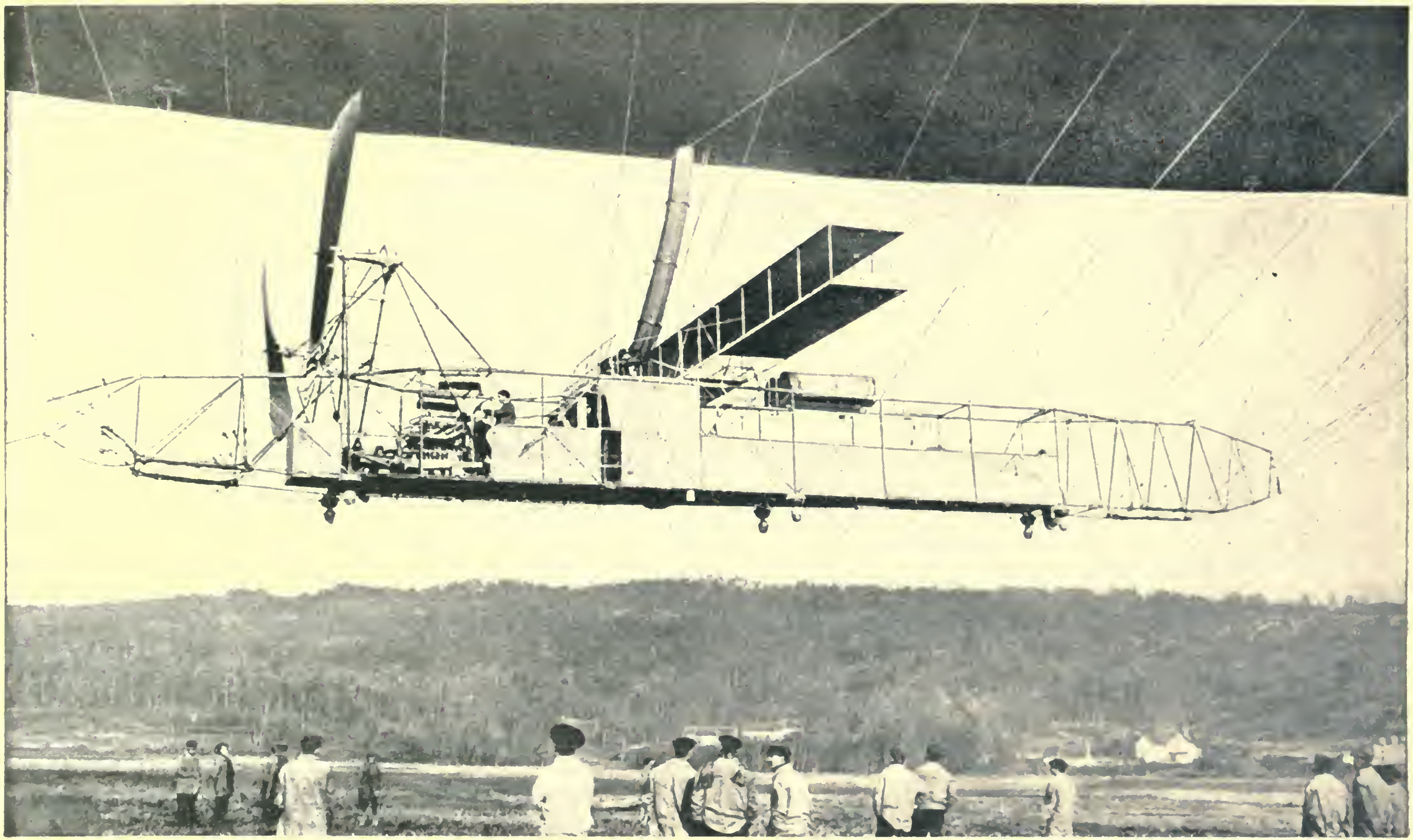
INSIDE AN AMERICAN AIRSHIP BUILT FOR CROSSING THE ATLANTIC. AN AIRMAN IS ASLEEP ON THE RIGHT

THE MEN OF DEATH SOAR INTO THE HEAVENS AND PASS OVER THE WORLD BY NIGHT

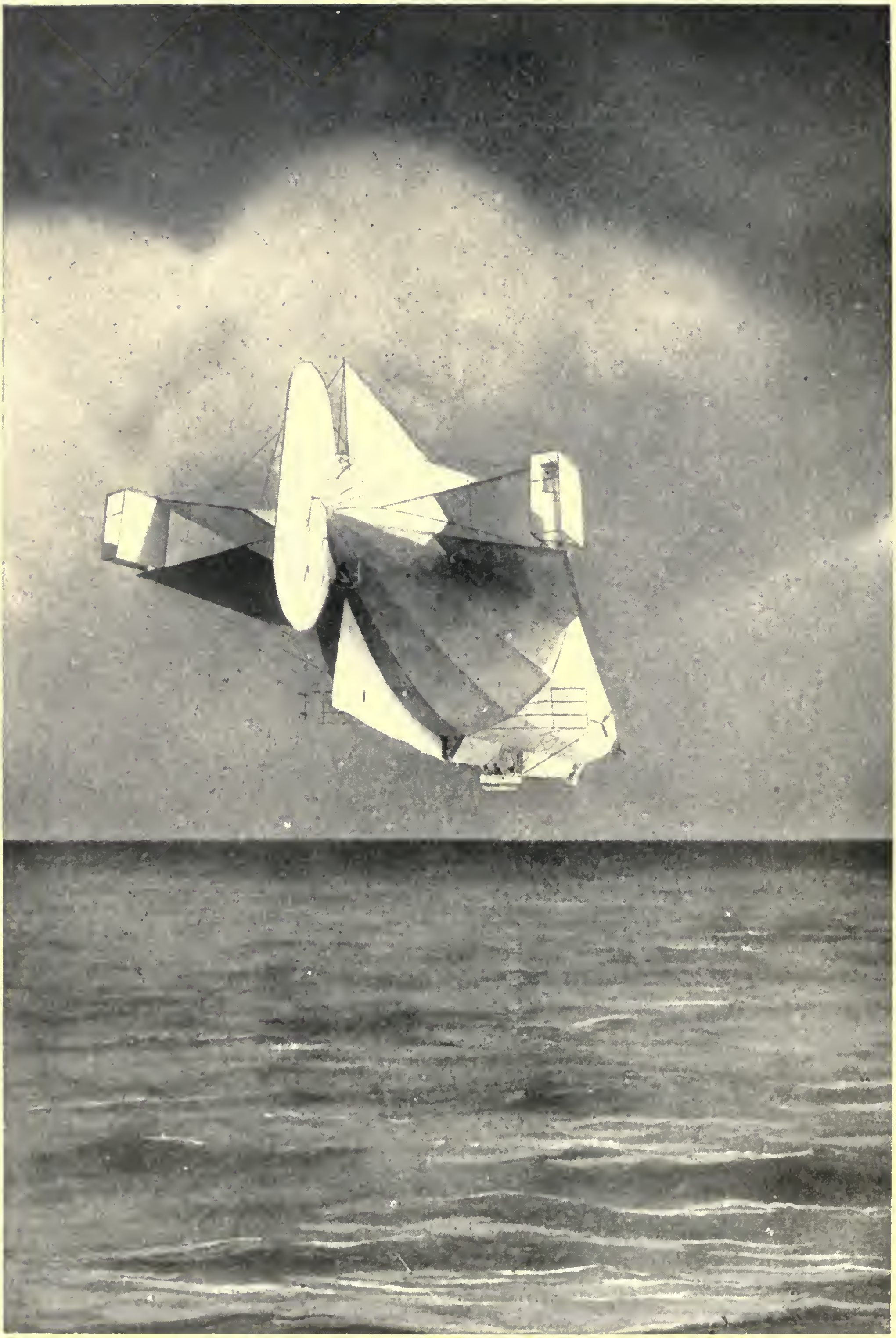


A THRILLING SCENE IN THE CLOUDS IN THE DAYS OF THE GREAT WAR—IN THE LOOK-OUT CAR OF AN AIRSHIP

THE MARVELLOUS MOTOR-CAR THAT MAN HAS THROWN UP INTO THE CLOUDS



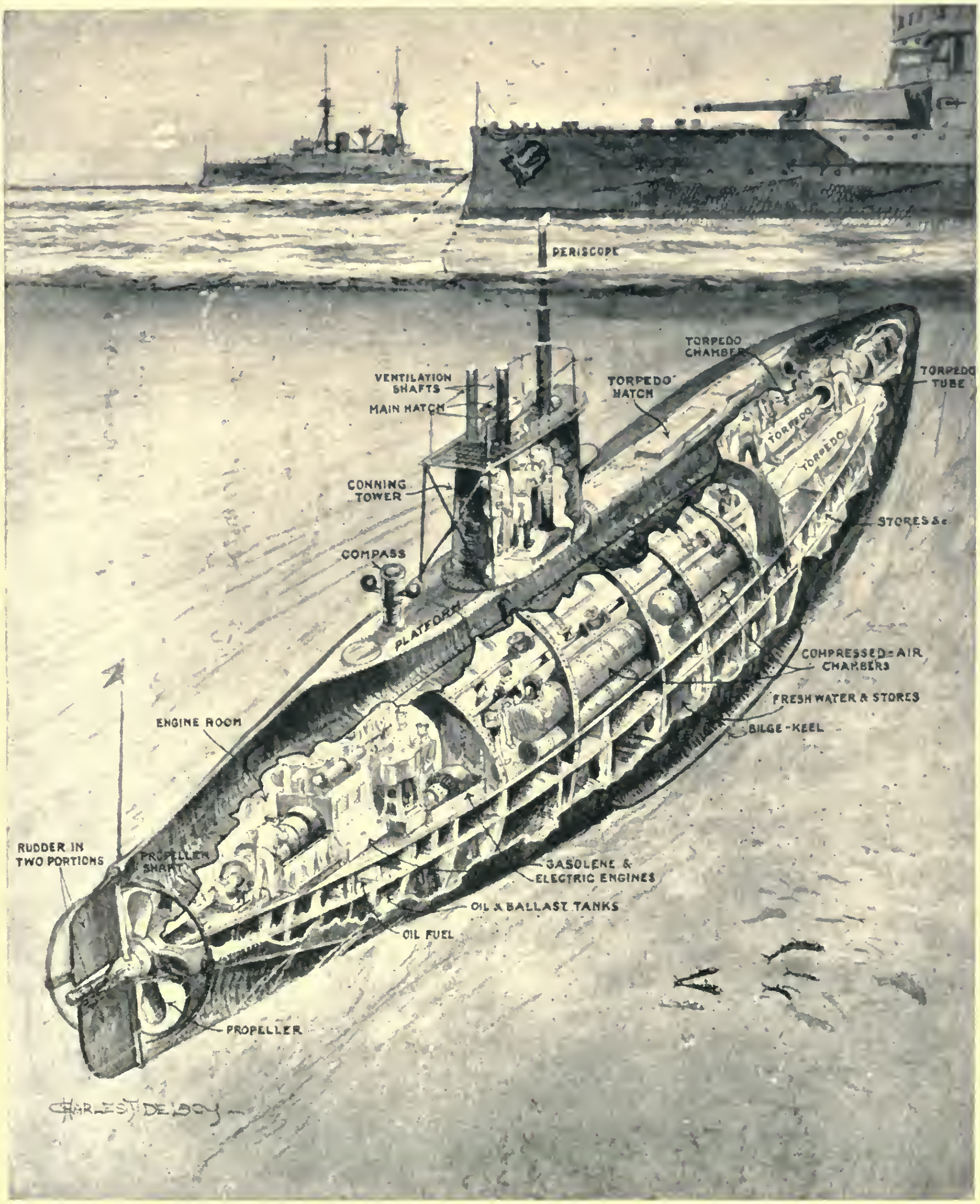
THE GREAT CAR OF THE AIRSHIP, SHOWING THE TUBE-WAY LEADING TO THE TOP THROUGH THE BALLOON



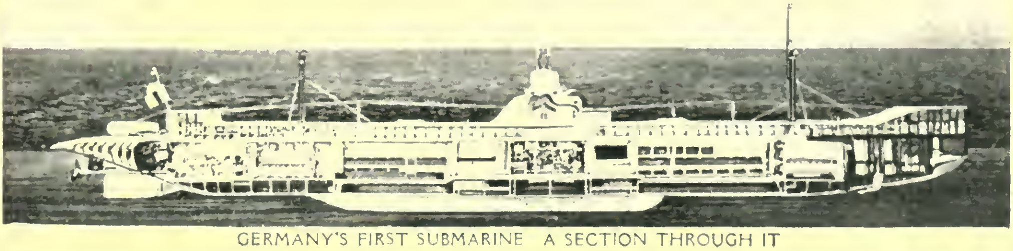
A ZEPPELIN OVER THE SEA

38 From The London Sphere, through the N. Y. Herald.

A LITTLE WORLD THAT GOES DOWN IN THE SEA

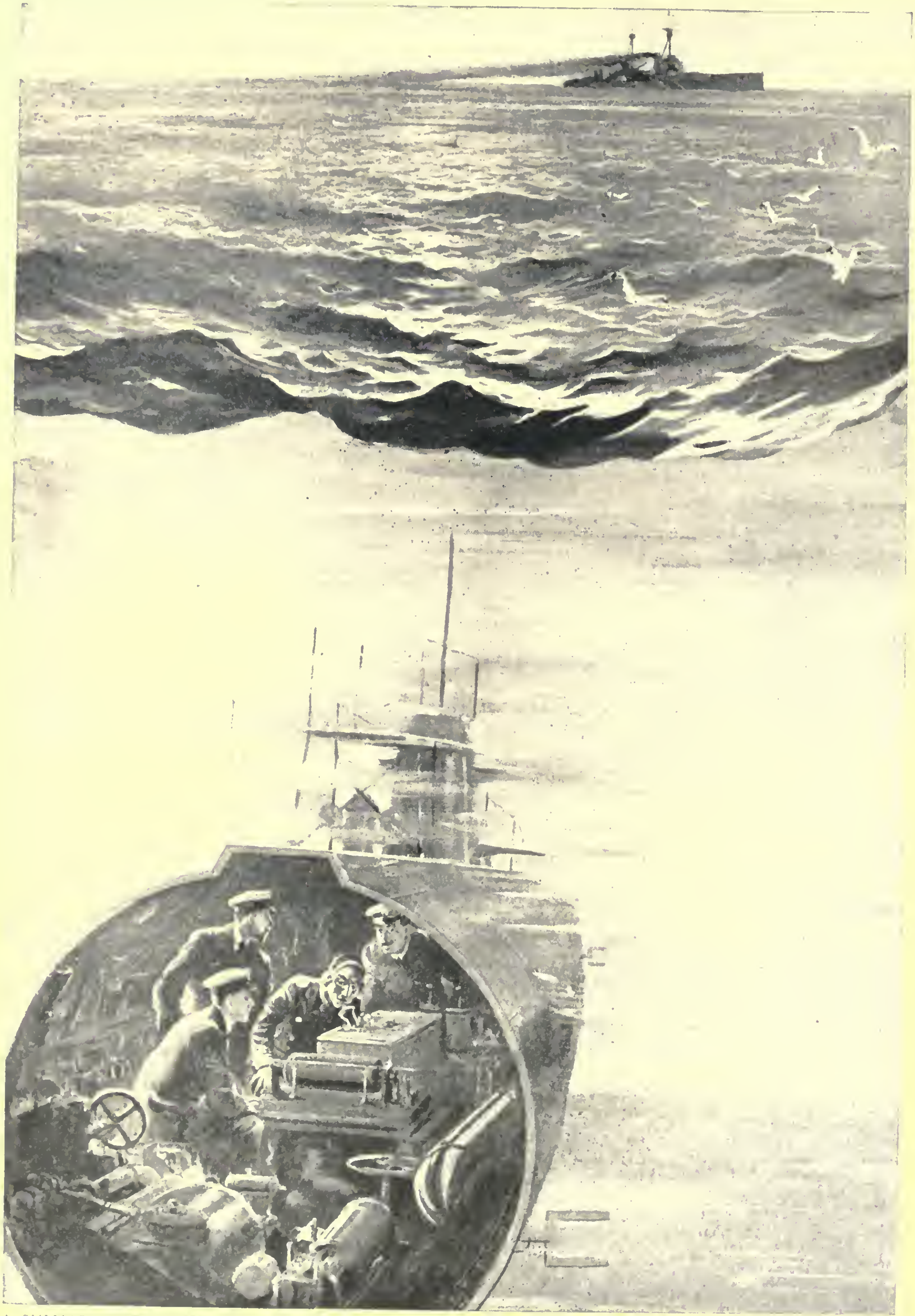


THE MARVELLOUS PACKING OF A SUBMARINE. SUBMARINES ARE NOW BUILT TO WEIGH 1500 TONS, WITH ENGINES OF OVER 7000 HORSE-POWER WITH TWO GUNS, SIX TORPEDO TUBES, AND WIRELESS



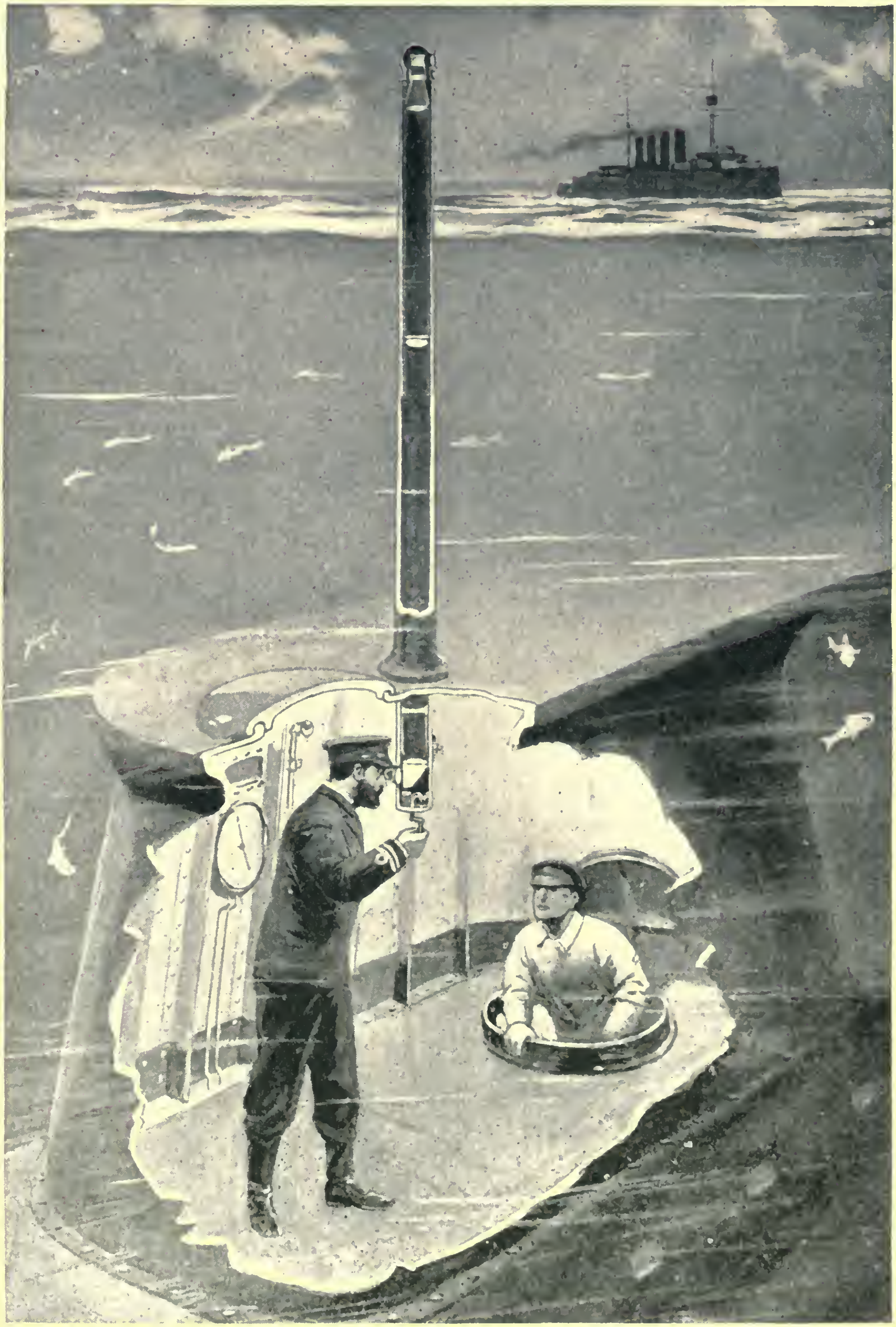
GERMANY'S FIRST SUBMARINE A SECTION THROUGH IT

A WARSHIP TALKS WITH ITS UNSEEN PARTNER



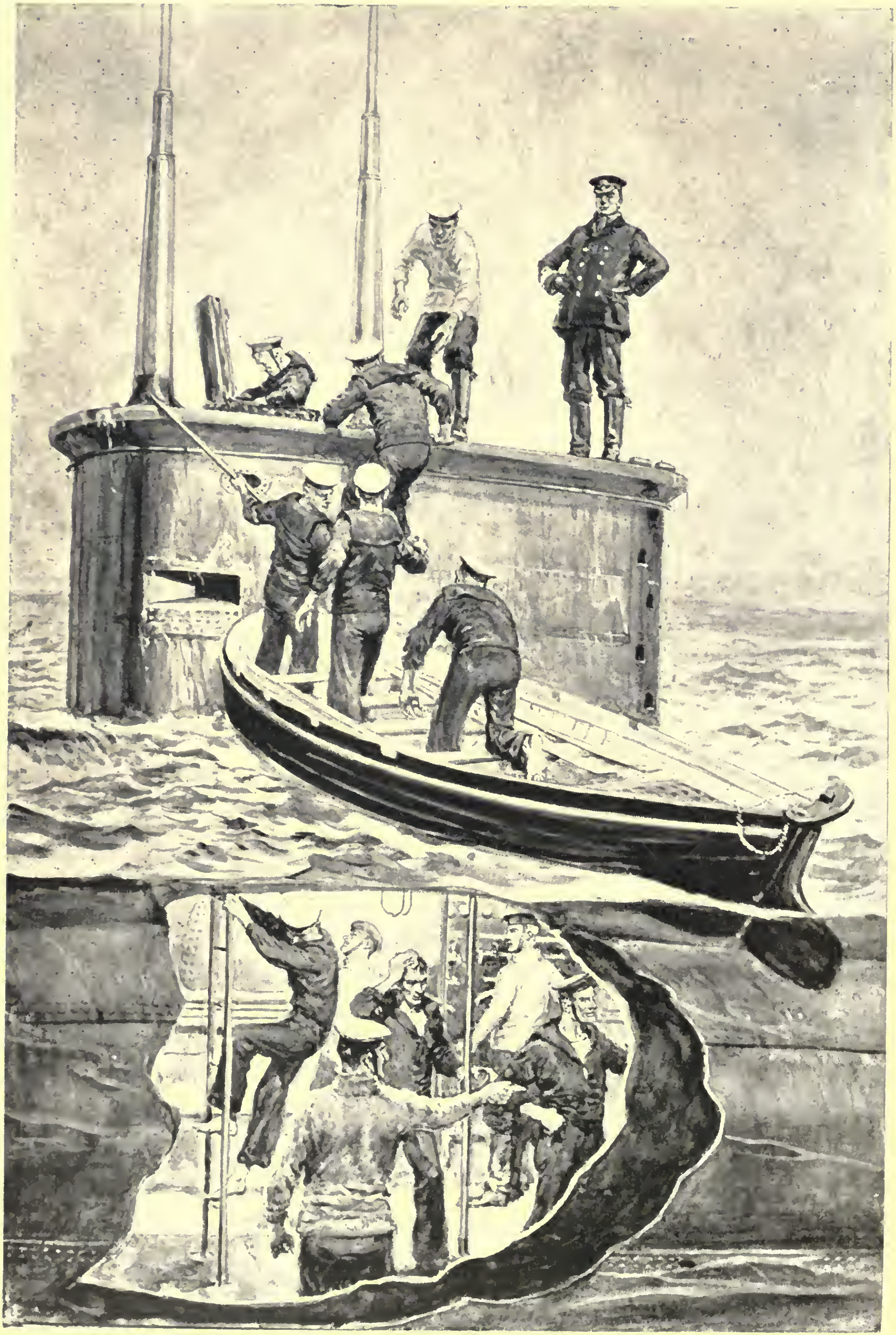
A SUBMARINE CAN NOW SPEAK TO A WARSHIP THROUGH AN ELECTRIC CURRENT CARRIED BY THE SEA, WHICH ACTS AS CONDUCTOR. THE "AERIAL" IS SEEN IN THE WATER

THE EYE OF THE MEN WHO RIDE IN THE WATERS



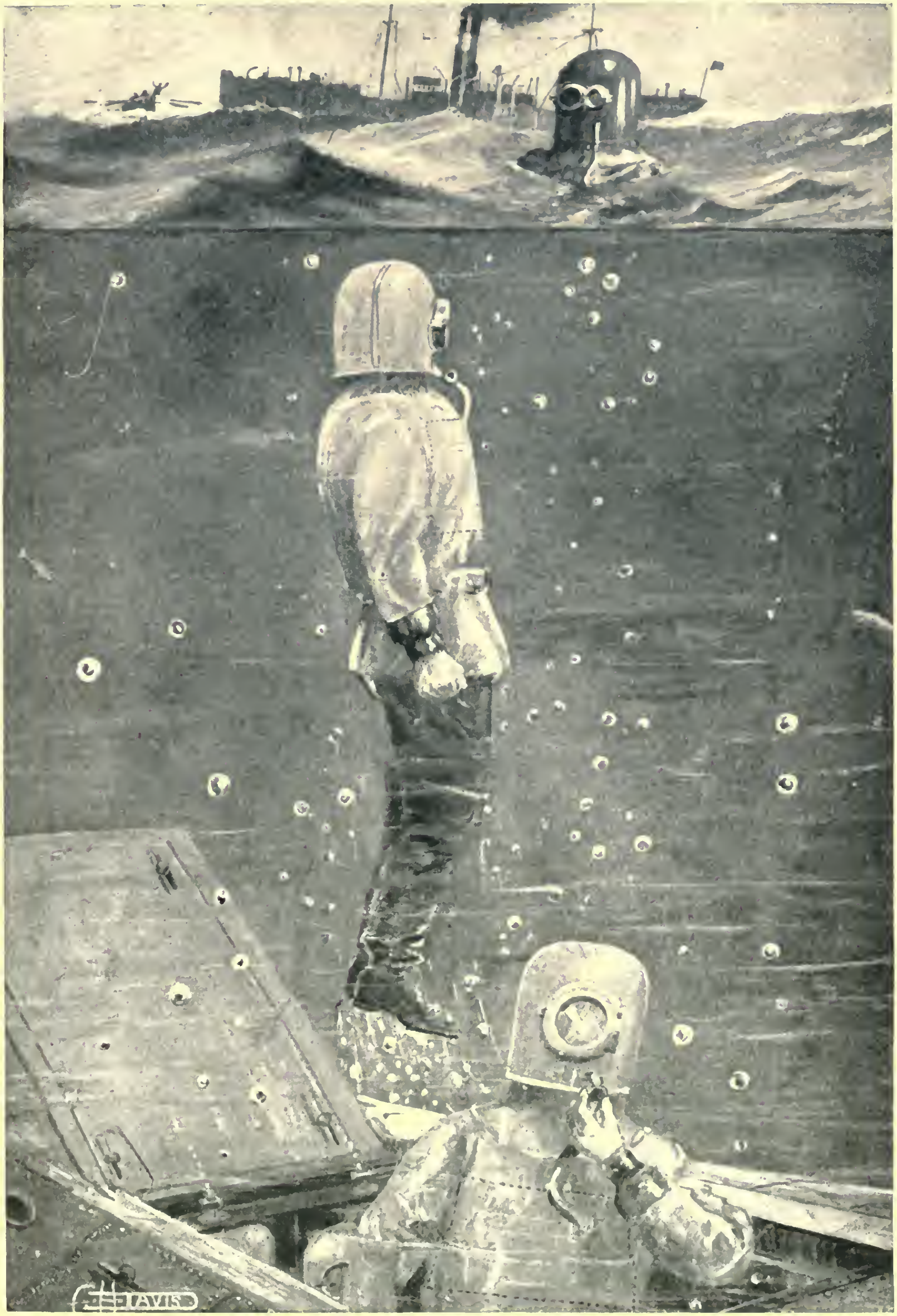
THE WATCHMAN IN THE ARMOURED CONNING TOWER BENEATH THE WAVES. THE PERISCOPE WHICH, ALMOST UNSEEN ITSELF, GIVES THE SUBMARINE A VISION OF WHAT IS HAPPENING AROUND IT

HOW THE MEN GO DOWN INTO THE WATERS



A SUBMARINE TAKING IN WRECKED SEAMEN FROM AN OPEN BOAT

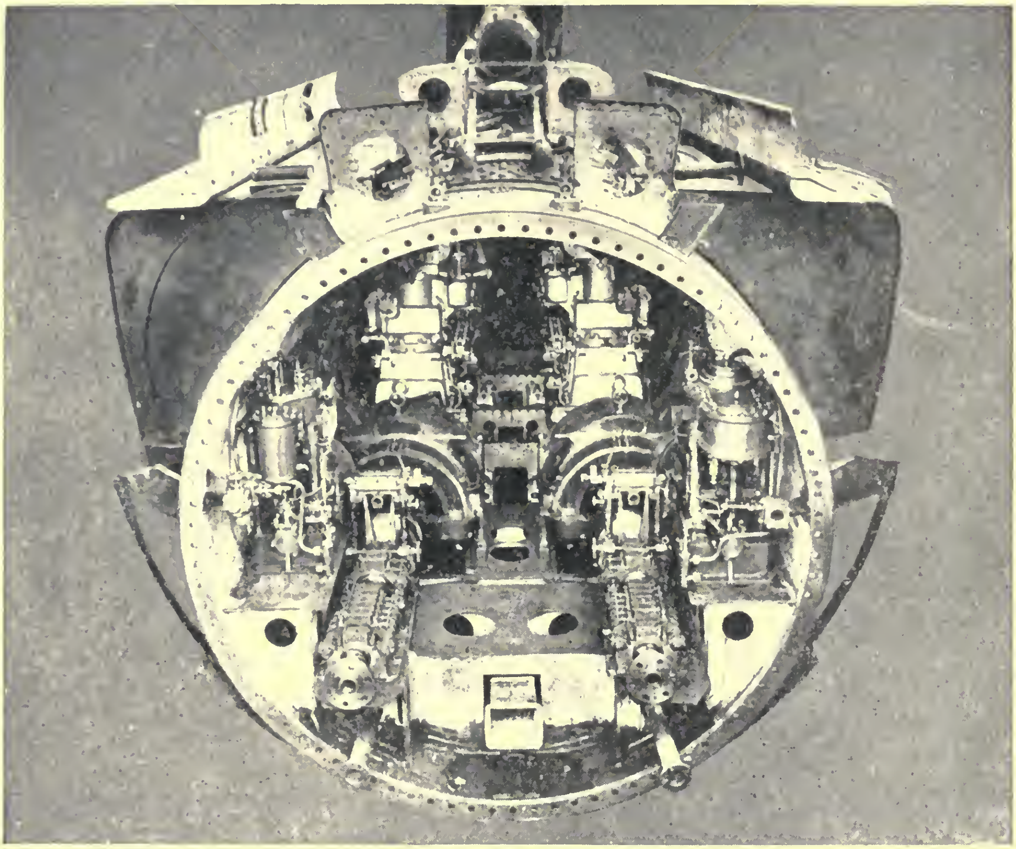
THE WONDERFUL HELMET THAT SAVES LIFE



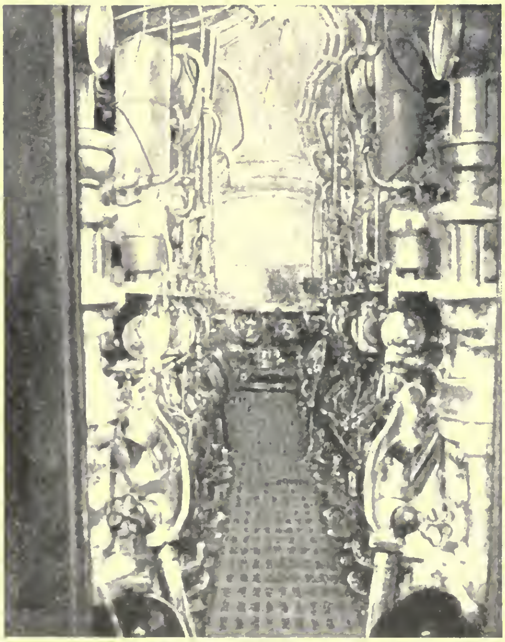
THE WONDERFUL SUBMARINE HELMET CONTAINING AN AIR PURIFIER, SO THAT THE WEARER CAN BREATHE THE SAME AIR AGAIN AND AGAIN IN WATER AND CONTAINING A FLEXIBLE CHAMBER IN THE JACKET WHICH THE WEARER CAN FILL WITH AIR SO AS TO KEEP HIM AFLOAT

From The London Sphere, through the N. Y. Herald.

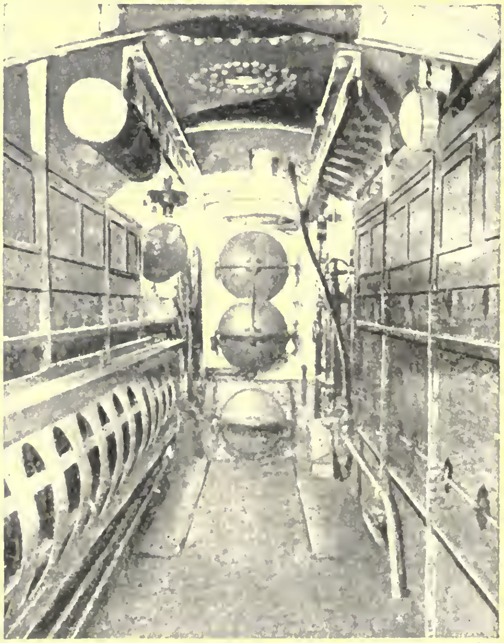
THE TERRIBLE THING MAN HAS PUT IN THE SEA



THE SHIP THAT SINKS IN THREE MINUTES CAN STAY ALL DAY AT THE BOTTOM OF THE SHALLOW SEA, CAN SEND OUT A TORPEDO TO DESTROY A SHIP LYING MILES AWAY, AND CAN RETURN TO PORT



THE MOTOR-ROOM ON A GERMAN SUBMARINE



THE TORPEDO ROOM ON A GERMAN SUBMARINE

Upper picture from The London Sphere, through the N. Y. Herald.

WHERE THE BANANAS COME FROM

THE STORY OF A NEW FOOD OF THE PEOPLE

A MARVELLOUS PLANT THAT GROWS ALMOST BY ITSELF

To speak of the banana as having arrested civilisation may seem very absurd, but it is by no means so ridiculous as it seems. If there is one outstanding fact of human life which is generally regarded as sure and certain, it is that which was expressed so bluntly by Paul when he said, "If any man will not work, neither shall he eat." We all regard work as a necessity of existence. The need for food awakens industry, and industry calls forth the best and highest powers of the human race. Civilisation is really the product of hard work, and without the necessity of working man would never have become civilised at all; he would never have developed his intellectual powers.

The truth of this can be actually proved, for there are living to-day people whose food, in the form of the banana, grows in such plenty at their doors that they have merely to pluck it and eat it, and can live practically the whole of their days without working. But, instead of Nature's bountiful generosity proving a blessing to them, it has been almost a curse. The ease and profusion with which the banana grows has made the natives hopelessly and incurably lazy, and has caused them to remain in the condition in which they have been for generations—only slightly raised above the lower animals.

In this way the banana, by its wonderful productiveness, has actually arrested the progress of civilisation in many parts of tropical America, where the people, finding food in such abundance, without the necessity of working to produce it, simply live to eat and sleep, and make little effort for anything beyond a mere animal existence.

It is a curious fact that the banana, although the most prolific of all fruits, nowhere grows wild. It has to be cultivated, and yet the cultivation that it needs is so trifling as scarcely to count; for all that is required is to remove the unnecessary suckers thrown up by the root, so that all the energy of the plant may be put into one stem and there produce a plentiful supply of fruit.

The banana grows abundantly in the tropical parts of America, and most of our bananas come from Central America; but it is not a native of the New World, and there is some doubt as to whether it was found here when Columbus made his great discovery. If so, it had probably been carried here from the Old World by ocean currents. But the general opinion is that it was brought to America from the Canary Islands by Spanish and Portuguese settlers.

There are a great many different kinds of bananas, most, if not all, of them being good for food. The one that we buy in our fruit-shops is the most common and also the most nourishing and delicious. A very distinguished English doctor said the other day that he wished all school children could have bananas from time to time, for they contain all the necessary elements for supporting life; and there is no doubt that if boys and girls would spend their pennies on bananas instead of sweets, they would be much stronger and better for doing so. Like oranges, the fruit is protected from dirt and impurity by its skin, which is a very great advantage where it is sold in towns.

The number of uses to which the banana can be put is amazing. It is unique among food-plants in this respect. The young sprouting leaves when boiled make an excellent vegetable for the dinner-table. The fruit can be eaten raw, or dried in the sun like figs, and it can be cooked in a hundred different ways. It makes a delightful jam, and from the juice, squeezed out, is made a very good wine that tastes something like cider. The dried fruit, ground into meal, forms a good flour for the making of bread and biscuits; and an expedition that went into Central Africa some years

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ago to search for Emin Pasha lived for a long time entirely upon it. The full-grown leaves, which are often ten feet long and two wide, are used for thatching houses; from the stem a medicine is made, and an ointment from the leaves. The fibre of the leaf-stalks is woven into canvas for the making of sacks and mats and even clothes; and the fibre also produces a very good and strong rope. In fact, the banana has been called the maid-of-all-work of the vegetable world. In the East it is known as "the food of wise men."

At weddings in many parts of India bunches of bananas and leaves of the plant are carried as symbols of the plenty which it is hoped the bride and bridegroom will always enjoy; and surely no more apt symbol could be chosen, for a single acre will produce 80,000 bananas a year, sufficient to provide over 200 bananas a day. This it will go on doing for ten years without the necessity of once having the soil manured or fed in any way.

THE MAN WHO INTRODUCED THE BANANA TO THE AMERICAN PEOPLE

Of course a pound of wheat contains more nourishment than a pound of bananas, but the great traveller Humboldt declared that the banana is about 133 times more productive than wheat, and 44 times more than the potato—that is, a plot of ground that will produce only one pound of wheat and three of potatoes will produce 133 pounds of bananas. Thus, a much greater number of people can live on a piece of ground planted with bananas than on a similar piece planted with wheat.

WHERE THE BANANA COMES FROM

Forty years ago the banana was almost unknown outside of the country where it grew. The few brought to our ports at the time were very expensive and were considered a great luxury. Now more than 40,000,000 bunches are imported annually, chiefly from Central America. The British Isles get their supply mainly from the West Indies.

This great increase in the banana trade is due to the efforts of Captain Lorenzo Dow Baker, a Cape Cod shipowner. After bringing a hundred bunches of wild bananas from Jamaica to New York, he realised the possibilities of the trade. So he began a campaign to educate the natives to cultivate the fruit and to pick it green. Since that time the trade has steadily grown, so that now several fleets of fast steamers are required to transport the fruit.

In Central America the banana is extensively grown for export, and some of the farms are twelve thousand acres in extent. To see a great tract of country all covered with banana plants is a magnificent sight.

THE ENORMOUS PLANTS THAT ARE CUT DOWN AT A SINGLE STROKE

The banana needs a warm, damp atmosphere, with plenty of water, either as rain or from artificial irrigation. The land is first cleared of all its trees and undergrowth; parts of the roots of old banana plants are then planted in little hillocks, three or four in each, only one plant being allowed to mature at a time. In about seven months the immense leaves spread out high above the ground, and the fruit-stem pushes out, bearing a large red bud on the end. As the bud opens, small yellow flowers appear. These later develop into bananas, from 100 to 150 growing on one stem.

An expert goes round the farm marking those plants whose fruit is ready for cutting, and then the stem is cut down with one stroke of a machete, a kind of weapon, half sword and half knife, that is used for all kinds of purposes in the West Indies and in some parts of Central America. The bunch of fruit is then cut off, and the stem left to decay upon the ground.

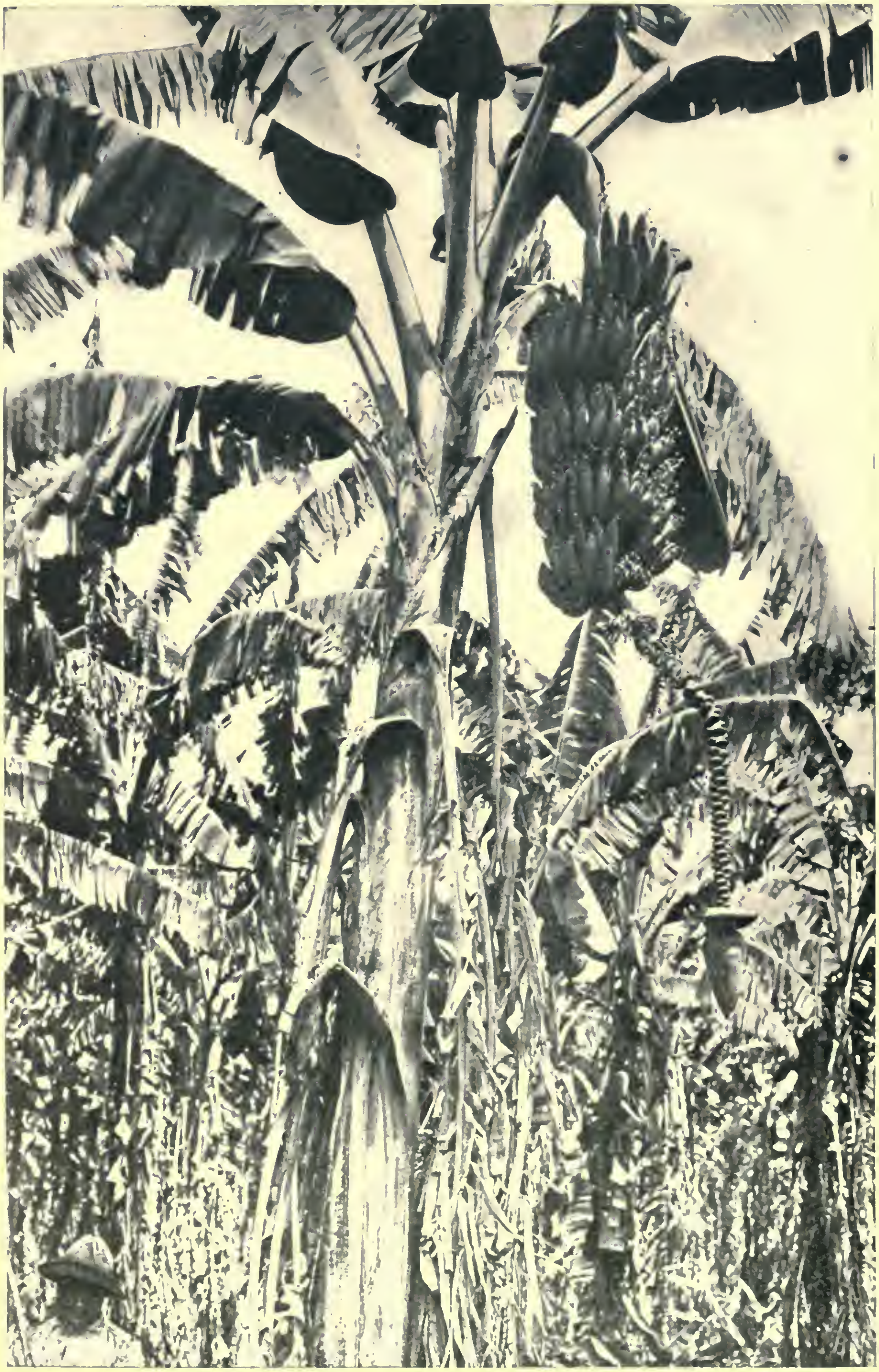
The women of Jamaica are very expert in carrying things on their heads, and can convey a heavy bunch of bananas in this way many miles without once stopping. Even the Jamaican children are taught to carry things on their heads as soon as they can walk, and boys and girls may often be seen running about playing tag with their school-books and ink-pots on their heads.

THE COLD AIR THAT BLOWS ON THE BANANAS AS THEY CROSS THE SEA

During their long voyage the bananas have cold air blown upon them by machinery, and when they arrive they are still as green as when they were picked. A short time in a warm room or warehouse soon ripens them for the market, and thus we get them in America as delicious and fresh as a native of Central America can pick them from the plant. Some of the ships engaged in the banana trade can carry more than six million bananas on one voyage.

No banana that is at all green, even only slightly at the ends, should ever be eaten. It should be kept until the whole of the skin is yellow; and although bananas that are soft may not appear so nice to the eye as those that are firm, they are better for eating.

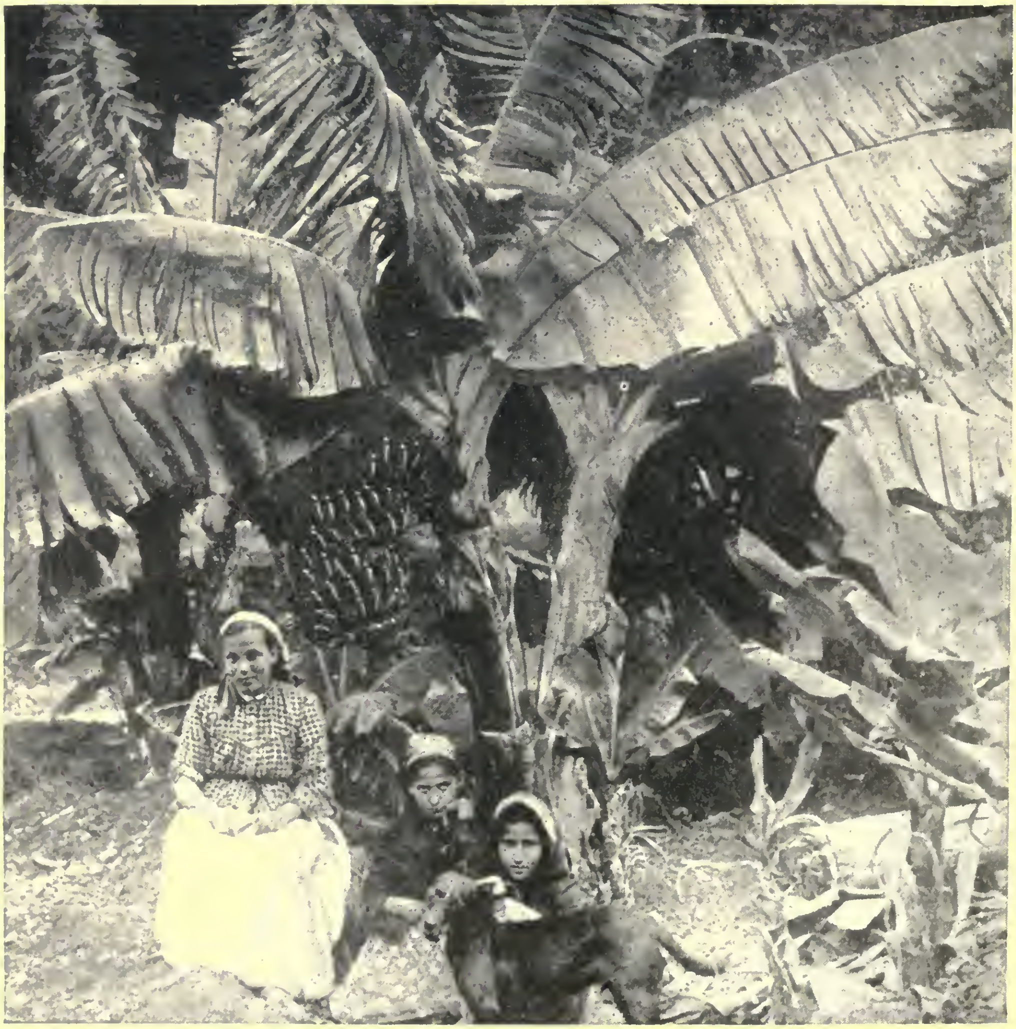
BANANA PLANT SHOWING BUD AND FRUIT



In this picture you see a banana plant and fruit. The immense leaves are torn by the wind. The bananas point upward instead of downward as we see them hung in the shops. The bud is all that is left of a beautiful large red bud, which enclosed the small yellow flowers from which the bananas developed. The markings show where the petals have fallen off.

HOW THE BANANA PLANT GROWS

The banana plant is the most wonderfully productive fruit in the world. It is a native of Asia, but most of our bananas come from Central America. In this picture we see labourers planting suckers of the banana plant on a farm in Ceylon.



Here the plant is full grown and the bananas ripe. From the time the suckers are planted to the gathering of the fruit is less than a year, so rapidly does the plant come to perfection. This photograph was taken in the Canary Islands.

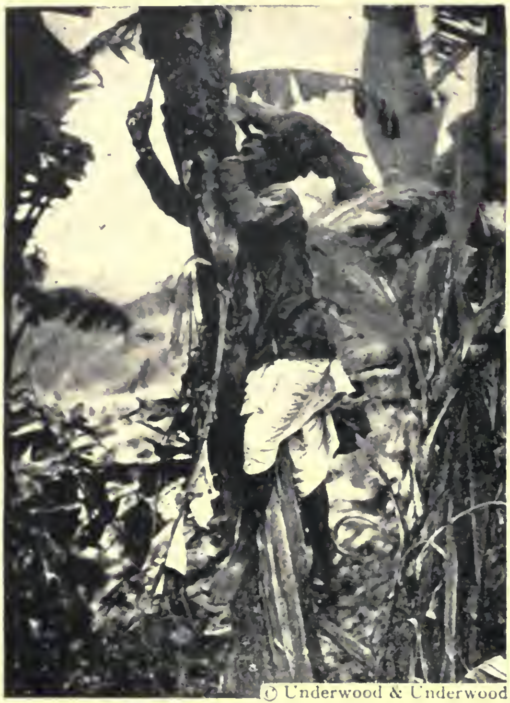
THE WATER THAT GIVES LIFE TO THE BANANA

© H. C. White Co.

Bananas need a great deal of water. They will only grow in a warm, damp atmosphere, and if much rain does not fall they must be supplied with water artificially. This is done by having canals between the rows of plants, as shown here.

Jamaica, which supplies most of the bananas that go to England, is an ideal country for banana-growing. The country is specially suitable, and the island is abundantly supplied with rivers. Here is a typical stream in the banana country.

CUTTING DOWN THE HUGE STEM AT ONE STROKE



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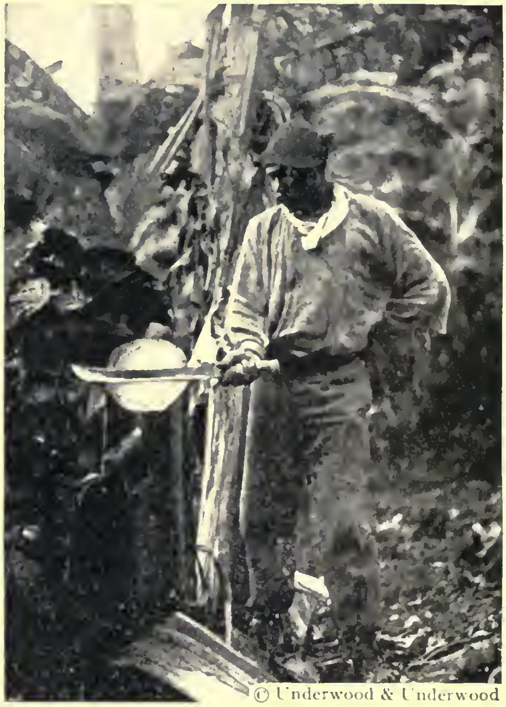

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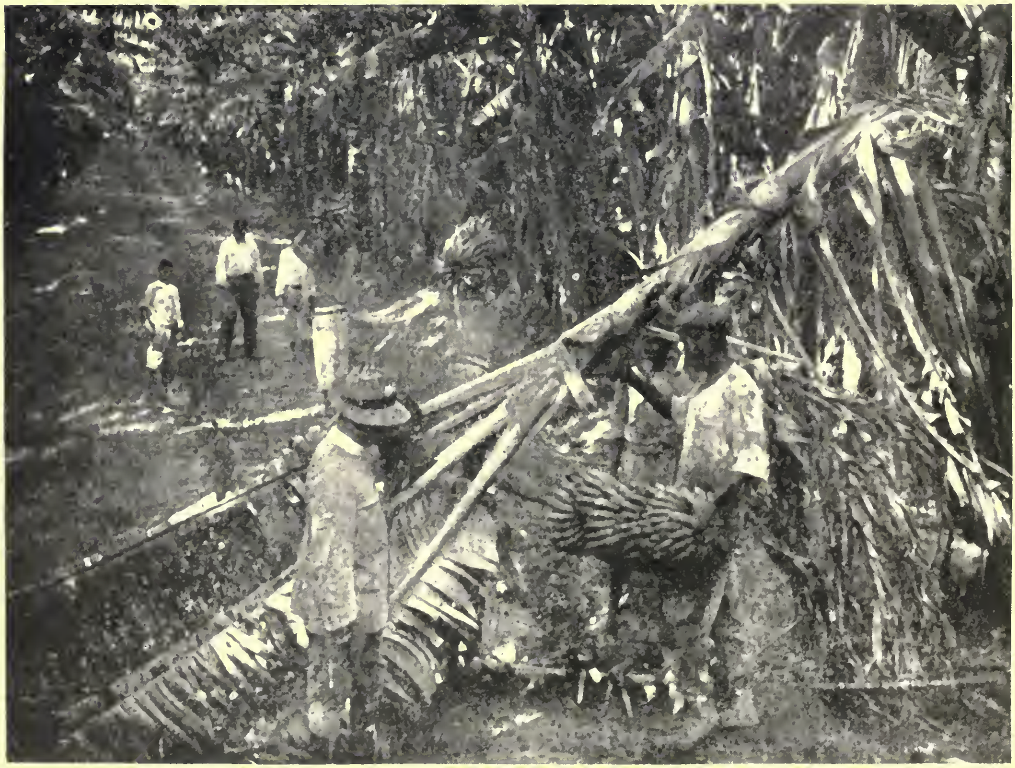
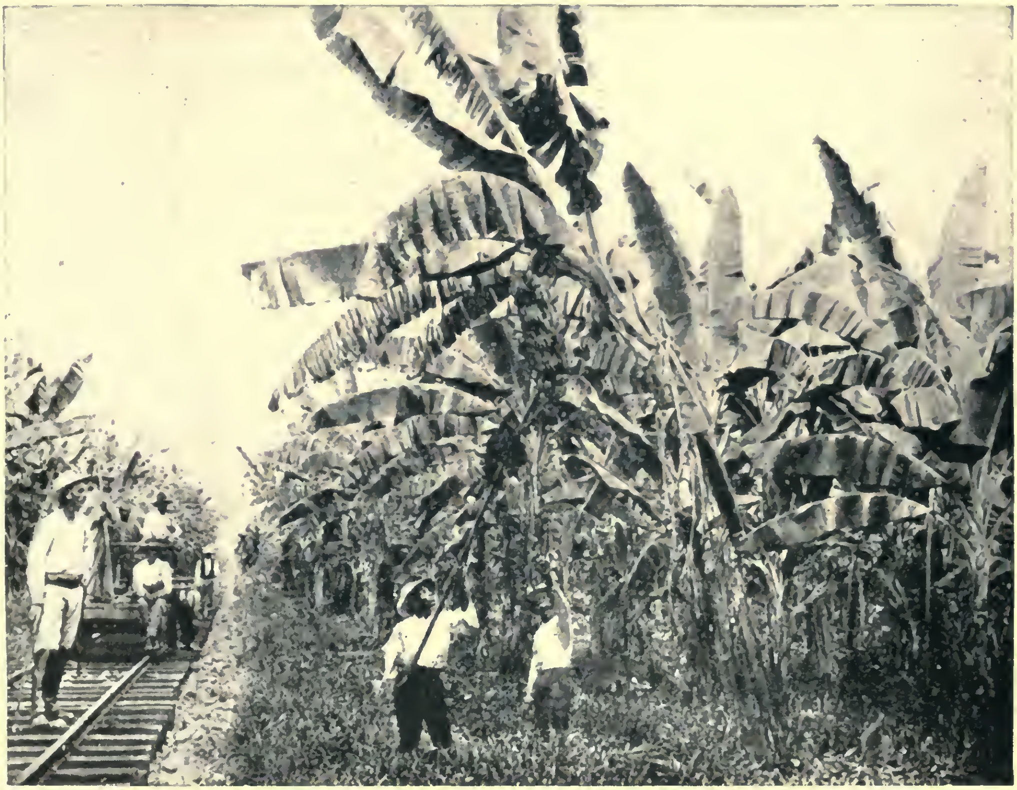
As soon as the fruit is ready for gathering, a man climbs up the great stem of the banana plant, as shown on the left, and with one slash cuts it down. The bunch of fruit is gathered, and then, with another cut, the stem is struck off, as on the right.



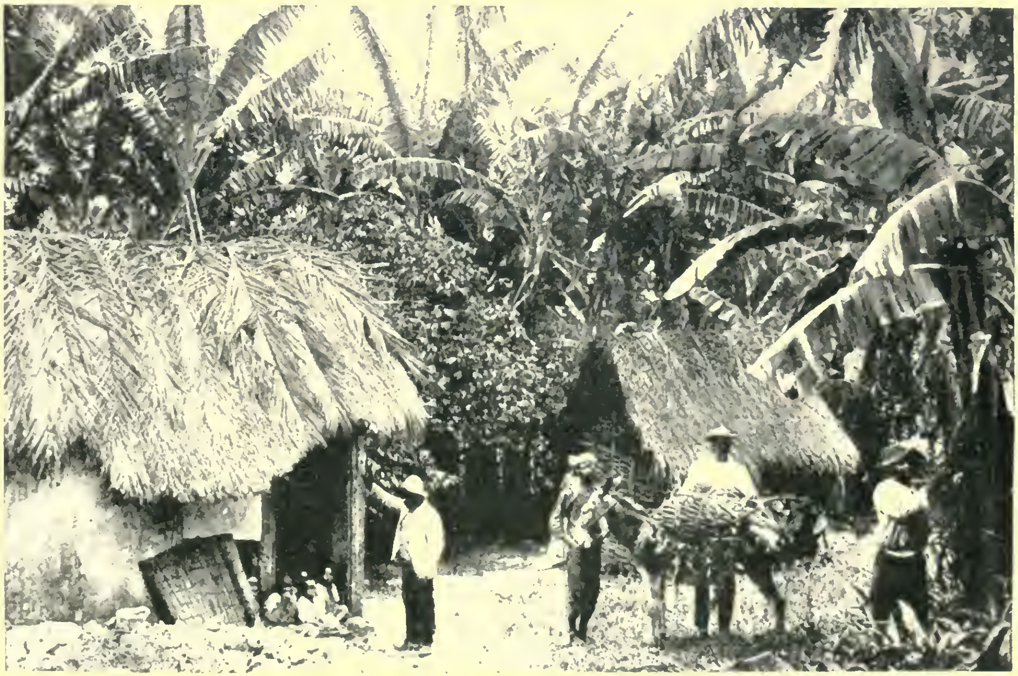
This picture shows how the stem falls when it is first cut down ready for the bunch of fruit to be gathered. In the West Indies and America the cutting is done with an instrument called a machete, which is half sword and half knife.

© Underwood & Underwood

GATHERING THE FRUIT ON A BIG FARM

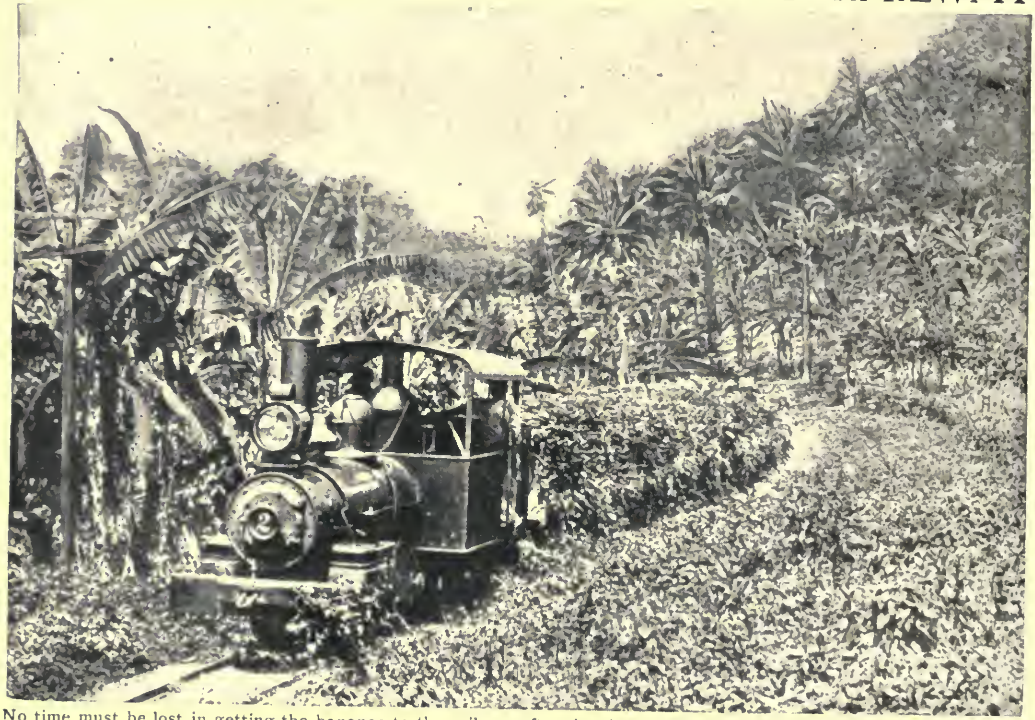


Some banana farms cover twelve thousand acres, and hundreds of labourers are employed. Here we see another way of cutting down the bunches on a big farm in Jamaica. After the fruit is gathered, the stems are always cut to the ground.

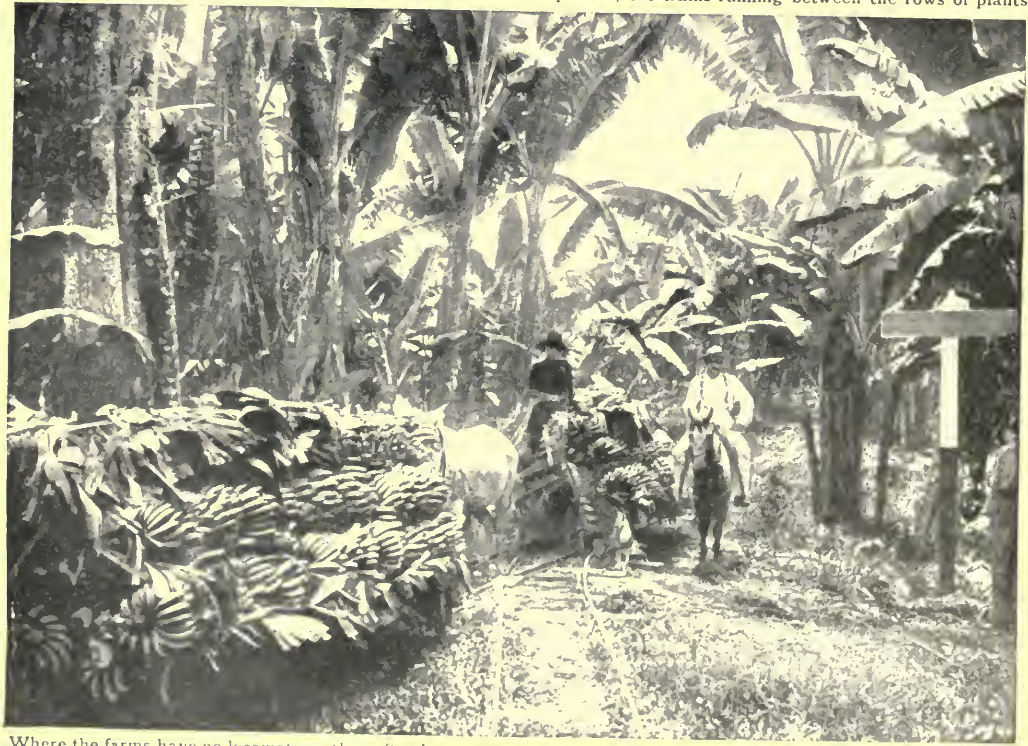


There are different ways of getting the bananas to the railways. Sometimes they are carried on the heads of women, and sometimes on mules, as shown in this picture. Many farms have light railways, as seen in the upper picture.

BRINGING THE BANANAS TO THE RAILWAY

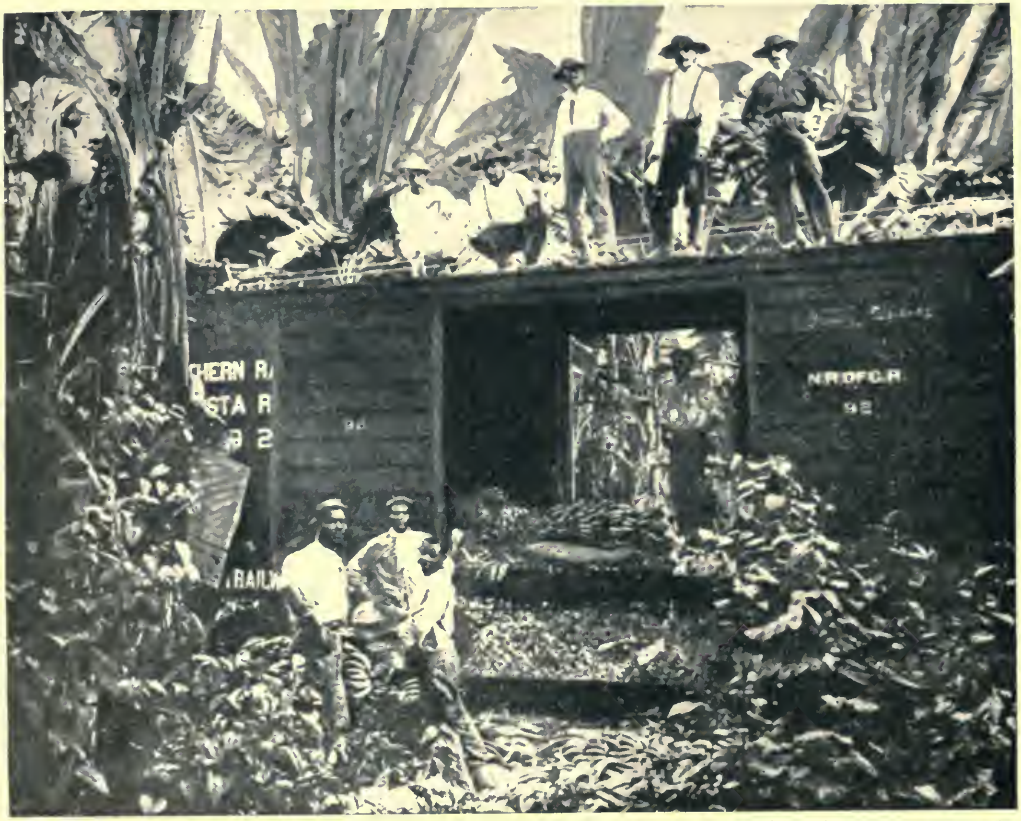


No time must be lost in getting the bananas to the railway after they have been gathered, and many of the big, up-to-date farms have little railways of their own like the one in the picture, the trains running between the rows of plants.



Where the farms have no locomotives they often have narrow tracks laid down in the plantations, as a mule can draw a much heavier load in a wagon running on rails than he can carry on his back. Here we see one of these primitive railways.

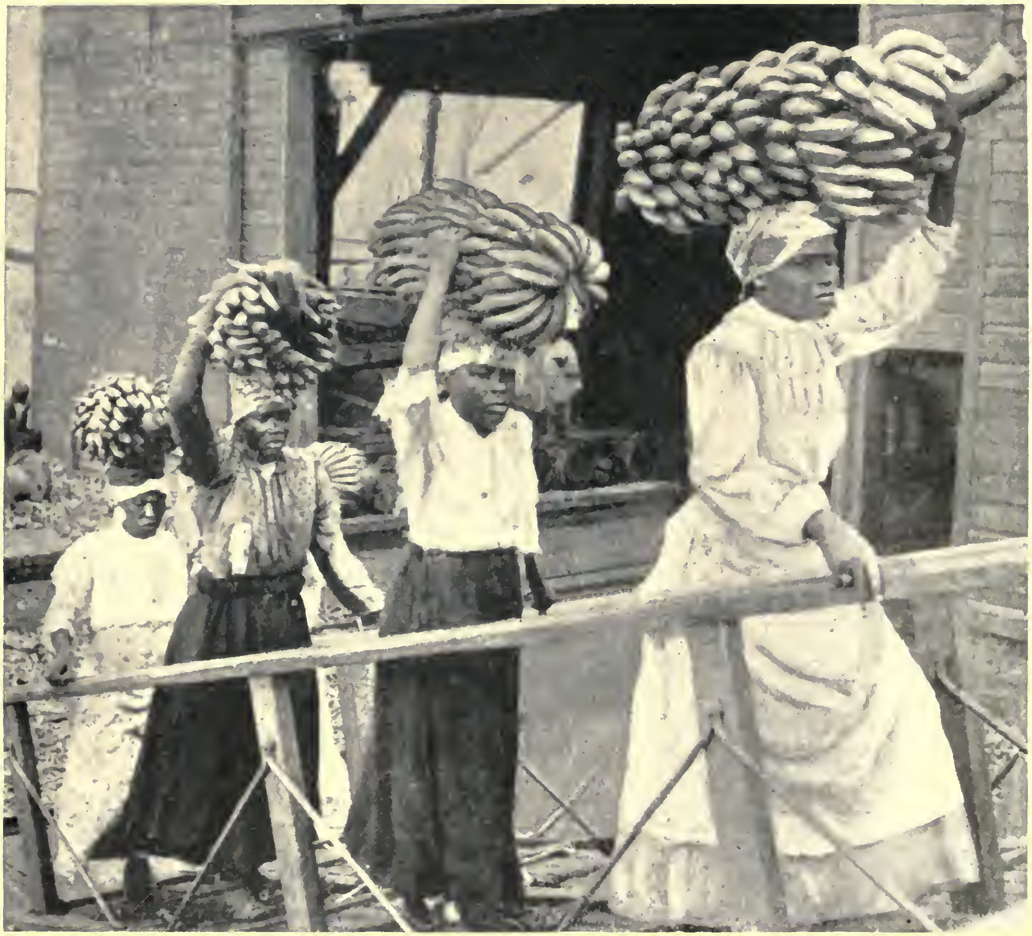
A MILLION BANANAS READY FOR LONDON



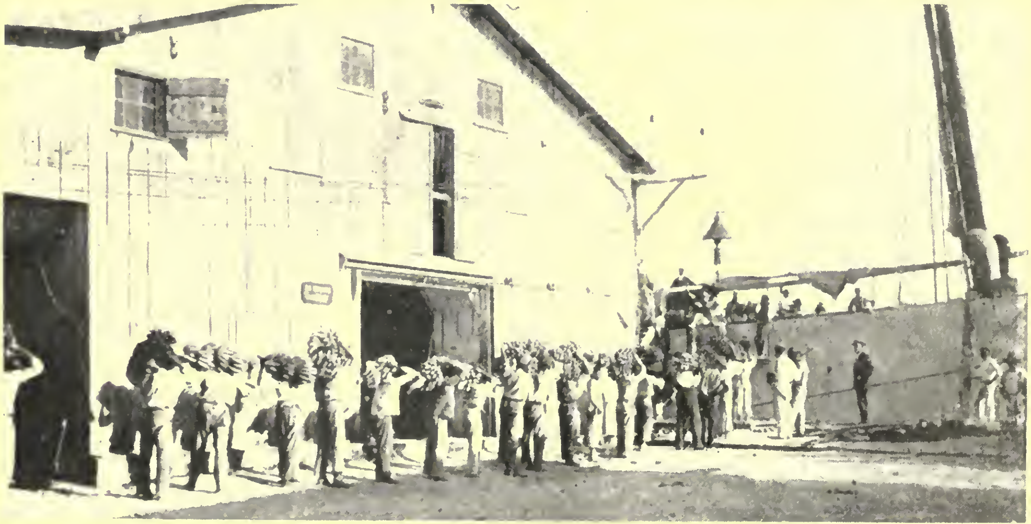
Here a great harvest of bananas has been brought to the railway ready for transport to the docks, where the fruit will be shipped to New York. A bunch has about a hundred bananas, and here there are something like ten thousand bunches.

In this picture bananas are being loaded into the railway cars that will carry them to the ship. The banana trade is now an enormous industry. A million bunches sometimes come to New York in a week, mostly from Central America.

THE PROCESSION OF BANANAS TO THE SHIP

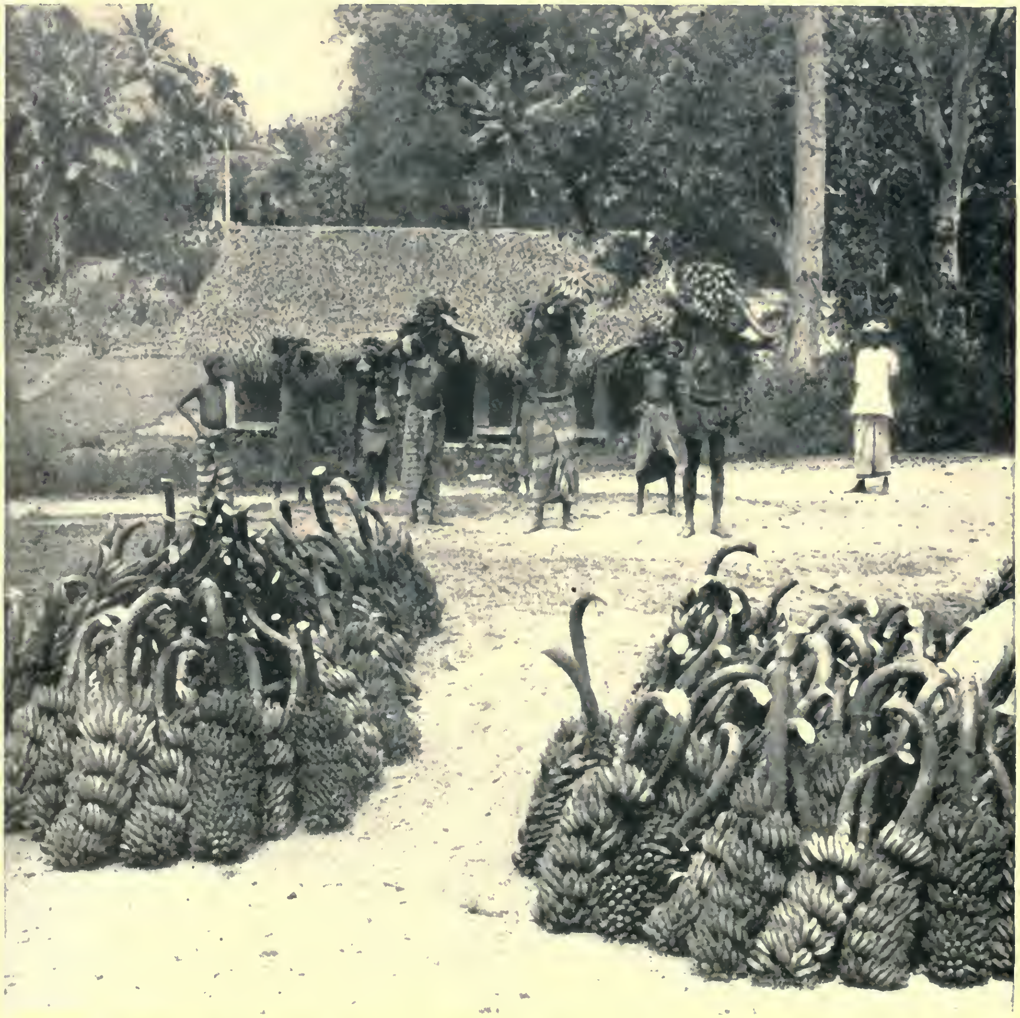


On arrival at the docks the bananas are placed in warehouses, and when the ship is ready for loading they are carried on board in the way shown here. Women do a great deal of this work, and are very skilful in carrying things on their heads

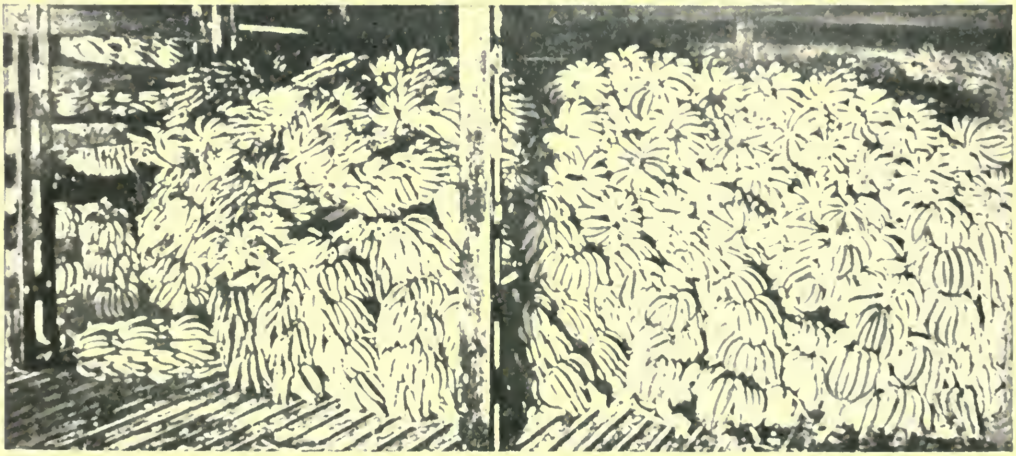


It is a striking sight to see the procession of bananas going on board. Men and women both do this work, and in the picture one of the steamers specially built to carry the fruit is being loaded. Forty years ago bananas were almost unknown except in the countries where they grew; now, many large steamers built specially for the purpose are engaged exclusively in this trade.

HOW THE BANANAS GO BY LAND AND SEA

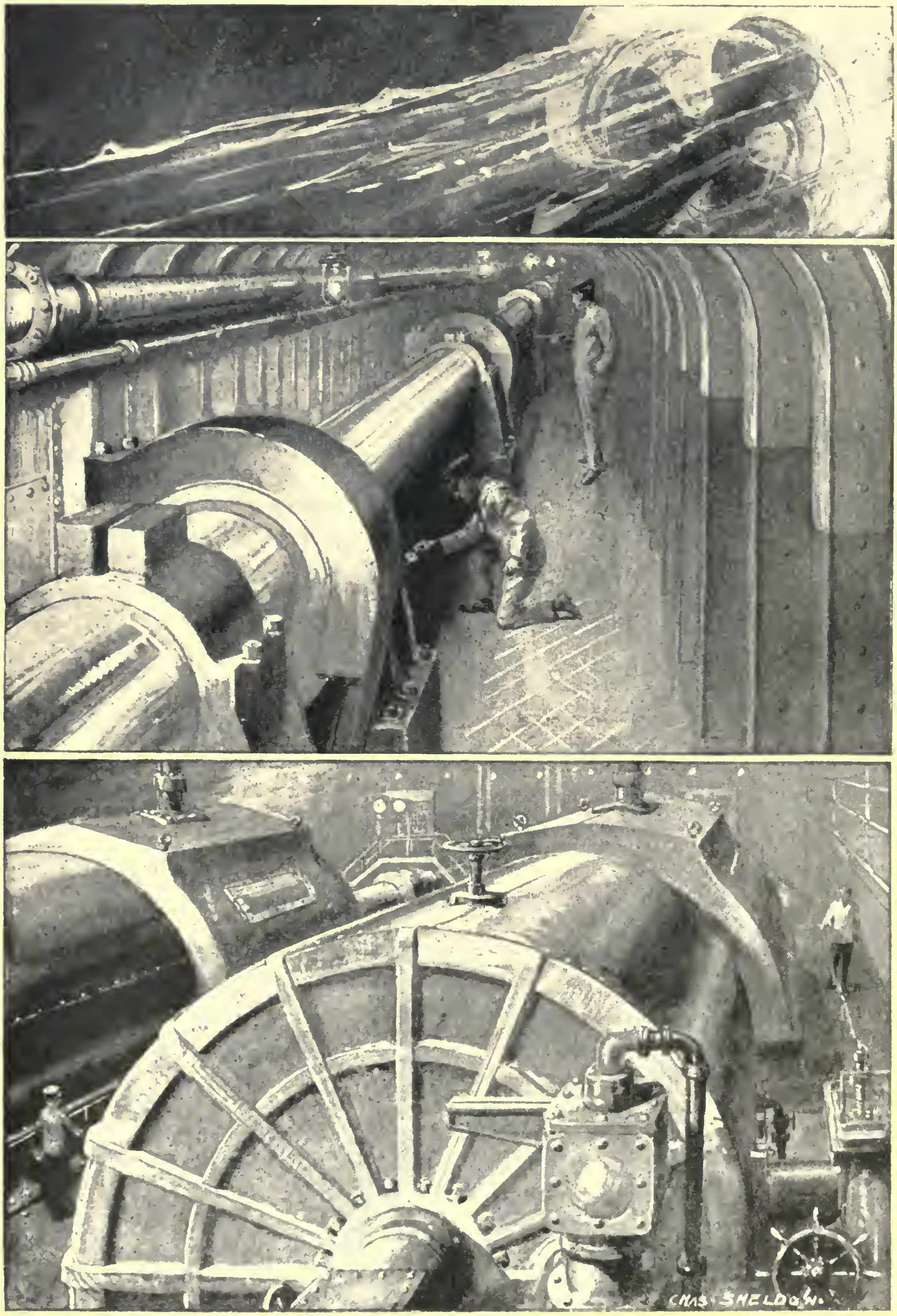


The method of gathering bananas is practically the same wherever they are grown, and here we see the bunches being brought to the railway by coolies in Ceylon. It will be seen that a large part of the stem has been left on each bunch.



This picture shows how the bananas are placed in the ship that brings them to America. They are gathered green, and cold air is blown upon them during the voyage. When they arrive, they can be soon ripened by being kept in a warm room.

THE SHAFT THAT MAKES THE PROPELLER GO


CHAS. SHELDON.

THE HUGE TURBINES SHOWN IN THE BOTTOM PICTURE DRIVE A LONG REVOLVING SHAFT, WHICH RUNS THE WHOLE LENGTH OF THIS GALLERY AND EMERGES IN THE SEA AT THE END, WHERE IT TURNS THE PROPELLER, AS SHOWN AT THE TOP, WITH A POWER EQUAL TO 20,000 HORSES

HOW A GREAT SHIP IS MADE

THE STORY OF THE COMING-UP OF THE OCEAN LINER FROM THE LITTLE STEAMBOAT OF LONG AGO

MEN WHO BECAME POOR THAT THE WORLD MIGHT BECOME RICH

SOMEBODY has been saying that the steamboats plying on the canals in Venice will wash away the banks on which the city stands, and perhaps even yet the rather ugly steamers which ply among the graceful gondolas may have to go. But they will scarcely go because they wash away the banks; it is just a hundred years too late to talk like that. A little over a century ago people were saying exactly the same thing about steam navigation in Scotland—not about many steamers, but about one, the only steamer then in the world.

It was quite a small steamer, so small that there was no thought of it ever going out to sea. It was made to haul barges on the Forth and Clyde Canal, in Scotland, and on the first day of its public trial, a day in March of the year 1802, it snorted gallantly along the canal, dragging two barges nearly twenty miles in six hours. A schoolboy can walk as far in the same time. But it was the first voyage ever made in Great Britain by a steamboat, and it was wonderful, as all first feats are. And then, when it was over, and the victory of the steamboat seemed won, the owners of the Forth and Clyde Canal declared that the vessel must not be used, as it would wash away the banks of their canal! So far as Great Britain was concerned, steam navigation seemed at an end, and the maker of the boat was almost broken-hearted. His name was William Symington, and he was one of those humble geniuses who have done so much for the world in the face of discouragement and hardship.

But he was not actually the first to make a steamboat. The idea of causing steam to drive an engine which should drive a paddle-wheel and propel a ship had been in men's minds ever since the properties of steam became known. Paddles, too, were old; the Romans had used them in their galleys, driving them by hand. The great thing was to get mechanical power to make the paddle-wheels turn in the water. As early as 1618 there was a suggestion for a steamboat in England, but the first attempt to put the idea into form was probably that of Denis Papin, a Frenchman, who was for a time a professor in a German university. In 1707 he built a boat, propelled by paddle-wheels, worked by the crew. With his family he embarked on the River Weser in this boat.

It happened that some suspicious boatmen heard what the model was supposed to do, and, fearing that it might ruin their trade, they destroyed it—just as in other days men in England broke up the machinery invented to do the work of their hands. Steamboats were destined to increase the trade of the sailor enormously, and machines were destined to increase industry beyond all dreams, yet sailors and workmen broke up all the machinery they could reach. A quarter of a century after Papin's misfortune, a clever Englishman, Jonathan Hulls, of Campden, in Gloucestershire, built a small steamboat, which had a paddle-wheel at the back, driven by a poor little steam-engine. He launched the interesting little stranger on the River Avon, but it was a failure. It is a strange thing that the name of the inventor was afterward remembered only through a cruel rhyme of the time:

> Jonathan Hull, with his paper skull,
> Tried hard to make a machine
> That should go against wind and tide;
> But he, like an ass, couldn't bring it to pass,
> So at last was ashamed to be seen.

We come then on to 1788, when Patrick Miller, a retired Edinburgh banker, was experimenting with a boat on a little lake in his grounds at Dalswinton, Dumfriesshire. The boat was driven by hand-worked paddles, but the labour was so hard that men could not continue at it. He was therefore introduced to William Symington, who, having been engaged to look after the machinery at a colliery, had made a steam-carriage in his spare time, He took his model to Edinburgh and showed it to a number of learned men, but could not carry out his scheme, because there were no roads in Scotland fit for a steam-carriage to run upon. The absence of highways, therefore, deprived Scotland of a steam motor-car, but this same cause gave her the steamship. Miller commissioned Symington to build him a little steamship, which was really two boats joined together side by side, with the engine in one boat, the boiler in the other, and the paddle-wheel working between the two.

HOW ROBERT BURNS SAW THE FIRST VOYAGE OF THE FIRST REAL STEAMSHIP

There was a fine gathering to see the first voyage of this little vessel on the lake on October 14, 1788. Robert Burns was there, and the future Lord Brougham, and others of note. Although the engine was small, it drove the boat about the lake at five miles an hour, and encouraged Symington to make another, which went at seven miles an hour. But poor Miller had spent too much money on the work, which brought him almost to bankruptcy, and he died poor and miserable, leaving Symington without a friend and without money. Happily, Lord Dundas, hearing of what he had done, enabled him to build a much larger vessel, which was called the Charlotte Dundas, after the nobleman's little girl. This, the first real steam-vessel of power, tugged two barges weighing 70 tons each along the canal, and caused the owners to fear that the banks would be washed away. The Charlotte Dundas was run ashore, and remained there to fall slowly to pieces ; and that ended poor Symington's career as a shipbuilder. He died a poor, disappointed man. His first engine, long kept in Miller's house as a sort of curio, had many strange adventures, and is now to be seen in South Kensington Museum.

HOW THE WIND CARRIED THE ENGINE OF A STEAMSHIP ACROSS THE SEA IN A BOX

Yet Symington, poor and disappointed, had achieved a revolution. He had taught the world that the steam-engine could drive a ship, and all the other steamships that followed were only developments of his. The great Olympic of today is the child of the little boat which was to wash away the banks of the canal. The immediate result was the building of a successful steamer in America by Robert Fulton, who was on the Charlotte Dundas when she sailed on her trial trip. He himself had tried to build a steamer, but the bottom of his ship fell out, and let his engine slip into the water—just as the engines of the Titanic are said to have fallen out before the ship went down.

Hearing of the success of Symington, Fulton came to England, took the idea of a steamship back to America, and perfected it there. But it was an English engine that drove his ship, built at Birmingham by Boulton and Watt and carried over to America in a box. It is odd to remember that the engine which was to revolutionise life at sea was carried across the Atlantic by the wind. Fulton's ship was launched in 1807, and as she steamed along at night the noise of her machinery and the sparks from her funnel so terrified the crews of other ships that they shrank beneath their decks or let their vessels run ashore, while others " prostrated themselves and begged Providence to protect them from the approach of the horrible monster which was marching on the waves and lighting its path by fire."

But the first really successful steamship in Great Britain came five years after Fulton's, and was the unaided invention of Henry Bell, a Linlithgow man. He had worked for years at the idea, and had profited by the experiences of poor Symington. He had met Fulton, too, and had frankly told the skilful American all his plans. These plans Bell laid before the Admiralty two or three times.

HOW SCIENTISTS REFUSED TO BELIEVE THAT SHIPS COULD BE DRIVEN BY STEAM

It is curious that Nelson, before going out to his last great fight and victory—Trafalgar—went over Bell's scheme and heartily commended it, though Napoleon had scoffed at the same idea when Fulton laid it before him in Paris. Nelson obviously had more imagination in this than Napoleon.

But scientific opinion was still against both Bell and Nelson. Sir Joseph Banks, one of the greatest scientists of that time, who did great things for England, sniffed and poohed at Bell's ideas. " It is a very pretty plan," he said, " a *very* pretty plan, but there is just one point overlooked that the steam-engine requires a firm basis on which to work." How could any man put fires and furnaces and boilers in wooden ships, when a storm would toss the vessel about, and the fire would be thrown all over the ship, so that the furnace must be put out at the very time it was most needed.

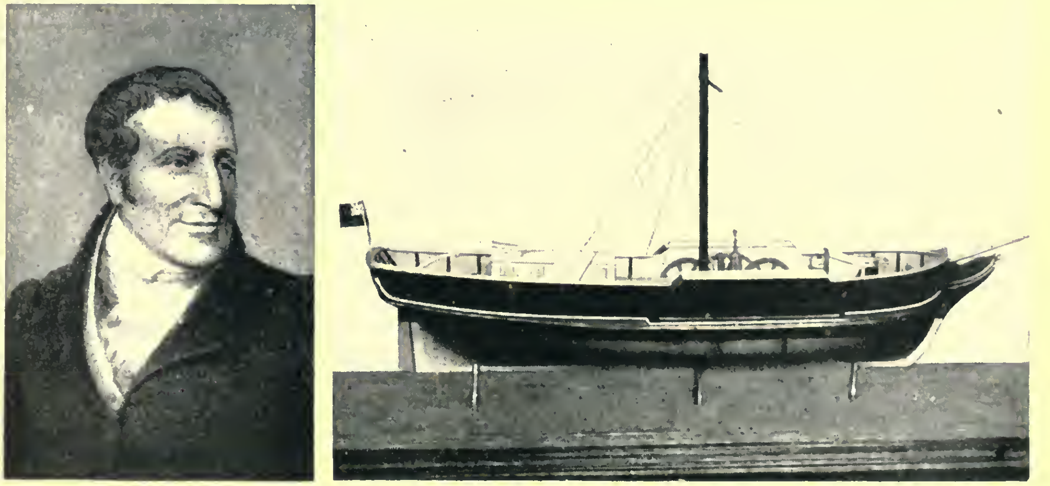
The brave heart of Henry Bell was not daunted by these rebuffs. He went to work on his own account, built a little vessel called the Comet, fitted her with an engine of three-horse power, and then, on August 5, 1812, issued the following historic document.

STEAM PASSAGE BOAT, THE COMET,

Between Glasgow, Greenock, and Helensburgh.

FOR PASSENGERS ONLY.

The subscriber having, at much expense, fitted up a handsome vessel to ply upon the River Clyde, between Glasgow and Greenock, to sail by the power of the wind, air, and steam, he intends that the vessel shall leave the Broomielaw on Tuesdays, Thursdays, and Saturdays, about midday, or at such hour thereafter as may answer from the state of the tide; and to leave Greenock on Mondays, Wednesdays, and Fridays, in the morning, to suit the tide. The elegance, comfort, safety, and speed of this vessel require only to be proved to meet the approbation of the public, and the proprietor is determined to do everything in his power to merit public encouragement. The terms are, for the present, fixed at four shillings for the best cabin and three shillings the second; but beyond these rates nothing to be allowed to servants, or any other person employed about the vessel.



HENRY BELL AND HIS COMET, THE FIRST STEAMSHIP TO CARRY PASSENGERS IN EUROPE

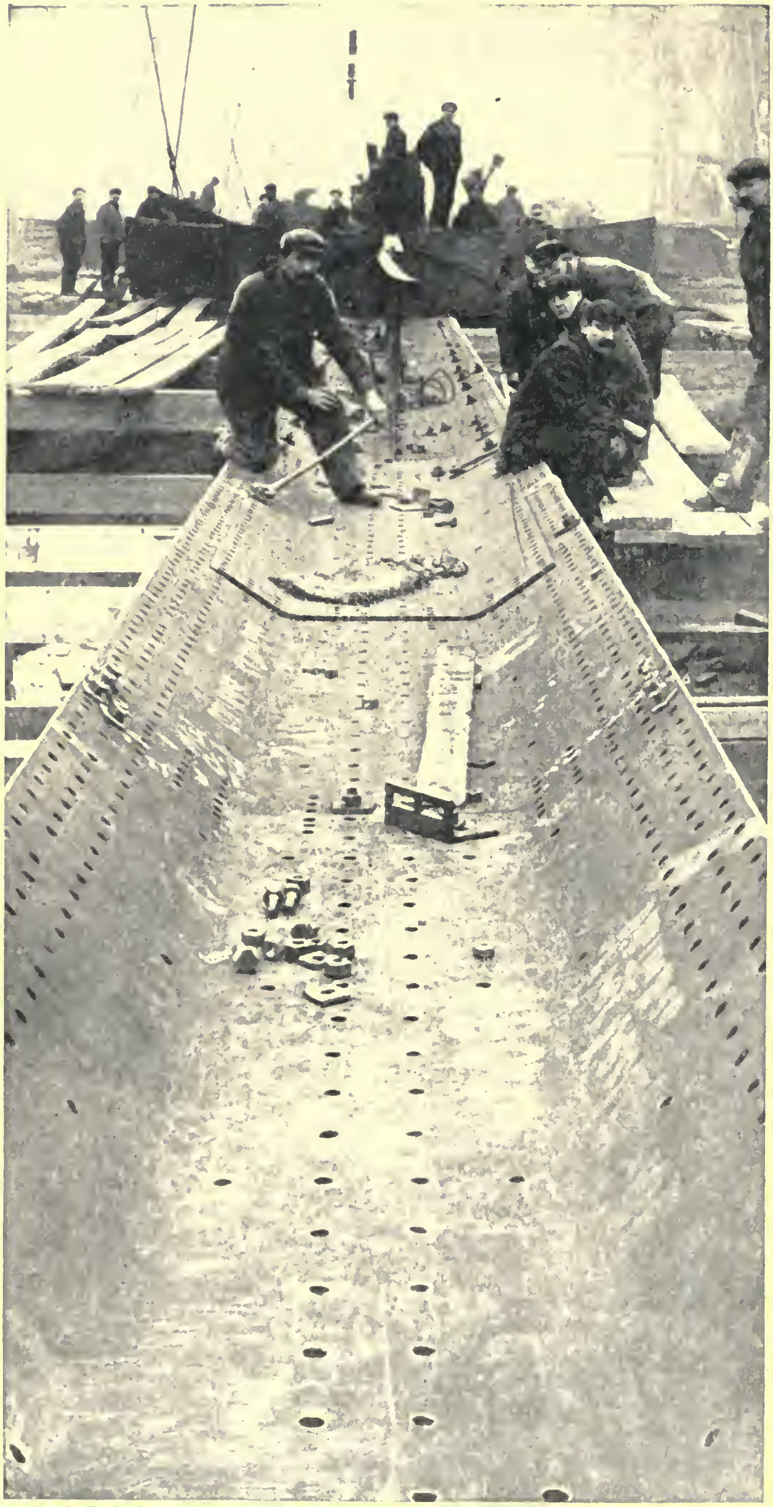
The little Comet was a great success in all but profit. There was much opposition from boatmen and coach-owners, and Bell, though he ran his little marvel for eight years before she was wrecked, lost all his money, and was rewarded in the end by a very small pension.

But Henry Bell did a great deal more than run this steamboat on the Clyde. From the first he avoided the mistake of Symington, who sought to keep to the canal; he went out into open water, bravely sailing to all parts of England, Scotland, and Ireland. He was the father of steam navigation in its practical form in Europe, and, once he had shown what could be done, steamships began to rise in all directions. In 1814 London had her first steamer on the Thames, the Marjory. In 1819 a little steamer, the Savannah, crossed the Atlantic to America; but as she was small she could not carry much coal, and depended largely on sails.

It was the problem of coal which brought the prophets of failure to the front again in 1838 a learned Dr. Lardner lectured at the Royal Institution, and "proved" that it would never be possible for a steamship to cross the Atlantic by steam alone, because she could not carry enough coal. Well, ships somehow did once cross, and have been crossing ever since. They became numerous, and the effect proved serious in an unexpected way. Our ships were of wood, as they had been since man first sailed the seas.

Now, in Britain forests are few and wood is scarce, and long before shipbuilding became a really great industry the country began to feel the need of material for building ships. A Government official, in 1841, showed that a wooden warship of that time used up timber which had taken eighty years to grow on seventy acres of land. All the royal forests in the kingdom could not supply the timber for one wooden battleship a year. To build the ships used in English commerce, the timber of eight hundred thousand acres would be needed every year.

It was imperative, therefore, that a new material should be found. Iron was proposed, and a terrible outcry the suggestion caused. "You might as well build ships of stone," said the critics. But the critics were wrong, for ships of iron were built. The younger Brunel built a splendid iron ship, called the Great Britain, and sent her steaming across the Atlantic in 1845. Even today people who live far from the sea can hardly believe that our ships are built of iron and steel, and it is only a dozen years since a member of Parliament asked it

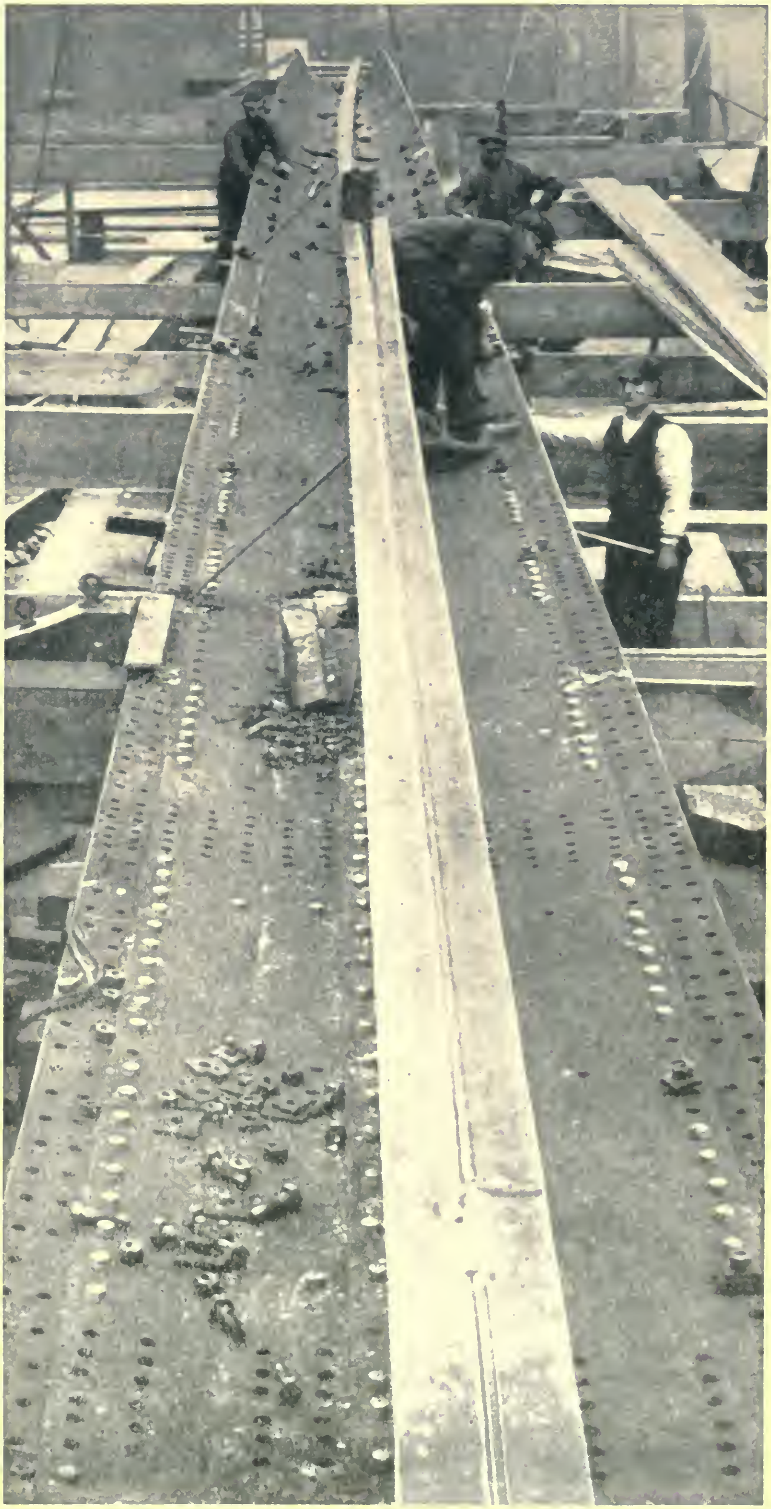


LAYING THE DOUBLE KEEL-PLATE THAT RUNS FROM END TO END OF A SHIP
The great cross girders at the end are seen in position on page 64; the upright plate in centre bears the T-piece shown opposite.

battleships were still made of wood. If a pin sinks in the water, how is it that a steel ship, weighing thousands of tons, can float like a feather? The secret was discovered 2000 years ago by Archimedes, when, as he stepped into a full bath, the water overflowed. Now, a body in water displaces exactly its own weight of water. If we throw into water a solid mass of iron weighing a ton, the iron will sink; but if we beat out the iron into an enormous hollow box, it will not sink. It still displaces its own weight of water, but its weight is distributed over a big surface.

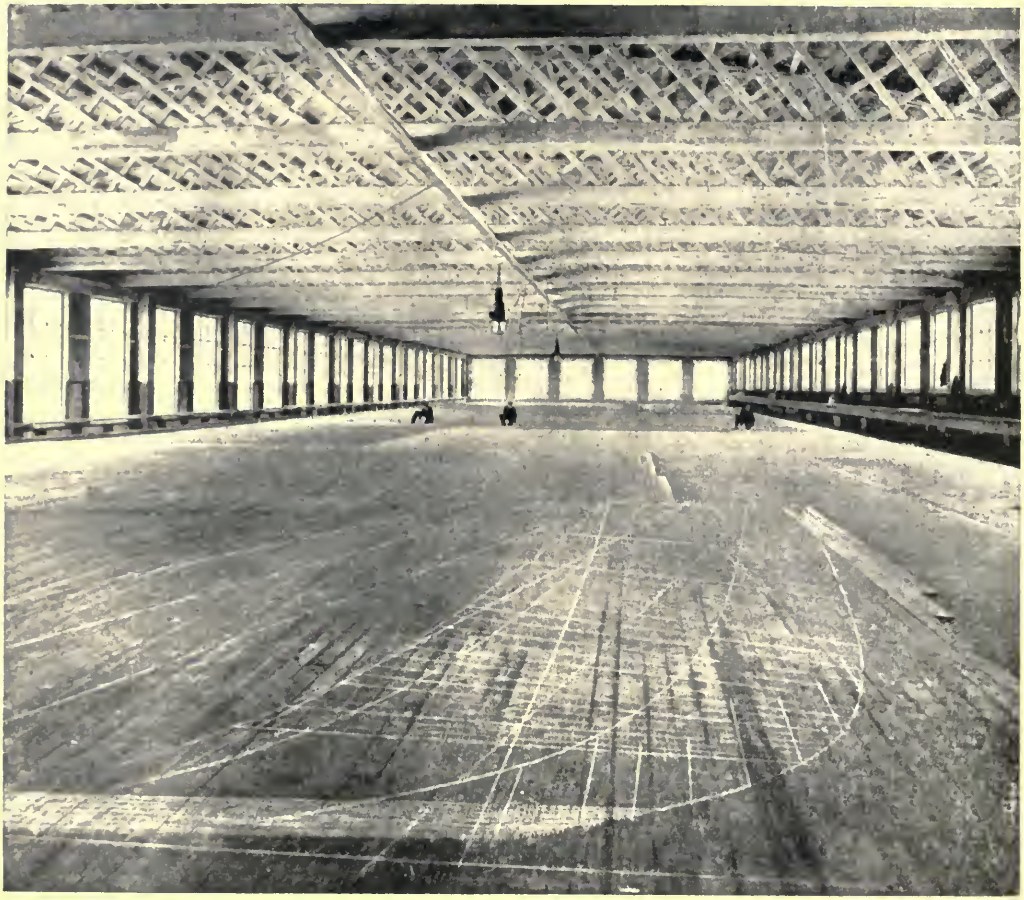
It is as easy for a vessel of fifty thousand tons to float, if it is spread over a great surface, as for an eggshell. If we throw into the water a new egg, it will sink; but if we pour its contents into a larger shell, which lies upon a greater space of water, it will float like a cork. The whole weight of a vessel of fifty thousand tons does not press upon one area, but is distributed over a great space, and if the ship is not overweighted so as to push aside too great a volume of water from beneath, it will float, whether it be of iron or wood. Nowadays big steamers and little are built of iron or steel, and their triumph dates back to the sailing of the Great Britain in 1845.

But it was not then her success so much as her failure that converted the shipbuilders. After she had been running for some time, she was accidently driven aground, and lay on the rocks for eleven months before she was got off. Shipbuilders went to see her as she lay stranded, and went again when she was removed into dock. They found that, in spite of the accident and the long exposure to the waves, she was practically uninjured. That converted them. The success of the metal ship really dates from that wreck. The whole story of the steamship has been one of daring effort by a few men without power or influence, and of stupid opposition on the part of those who were supposed to know best. Science has, of course, now come to the aid of the shipbuilder, and everything that concerns a ship is supposed to be worked out in theory before a beam is laid. But theory is not always right. The theory of the Titanic was that it was unsinkable, but she lies two miles deep in the North Atlantic Ocean — a terrible warning to us to remember that, with all our knowledge and our mastery of the sea, there are still things beyond the power of man to do and beyond the wit of man to understand.

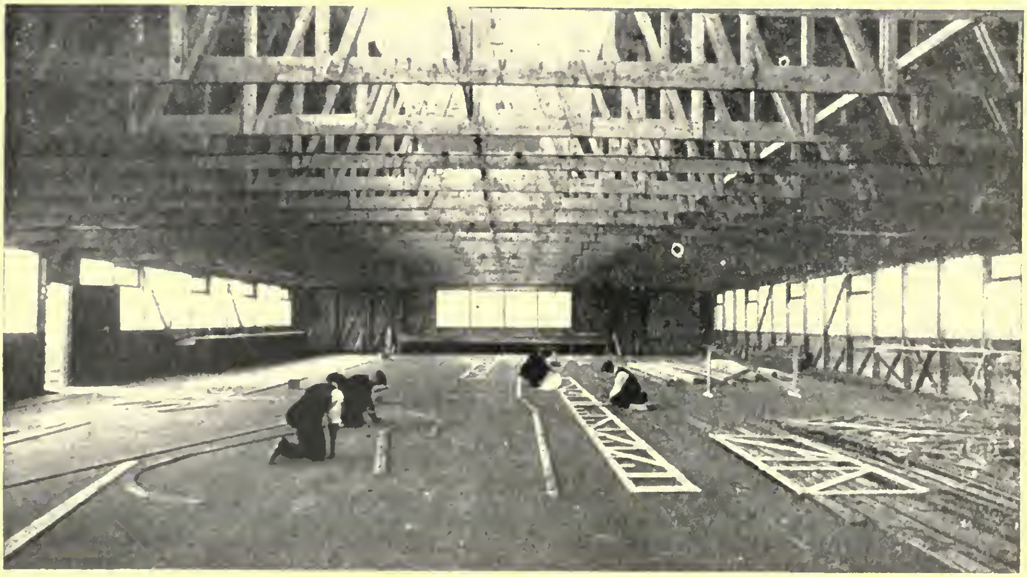


FIXING THE GREAT STEEL CENTRE-PIECE FROM END TO END OF A SHIP
The long T-piece in the centre is laid on the upright keel-plate seen on the opposite page

DRAWING THE FIRST PICTURES OF A BIG SHIP

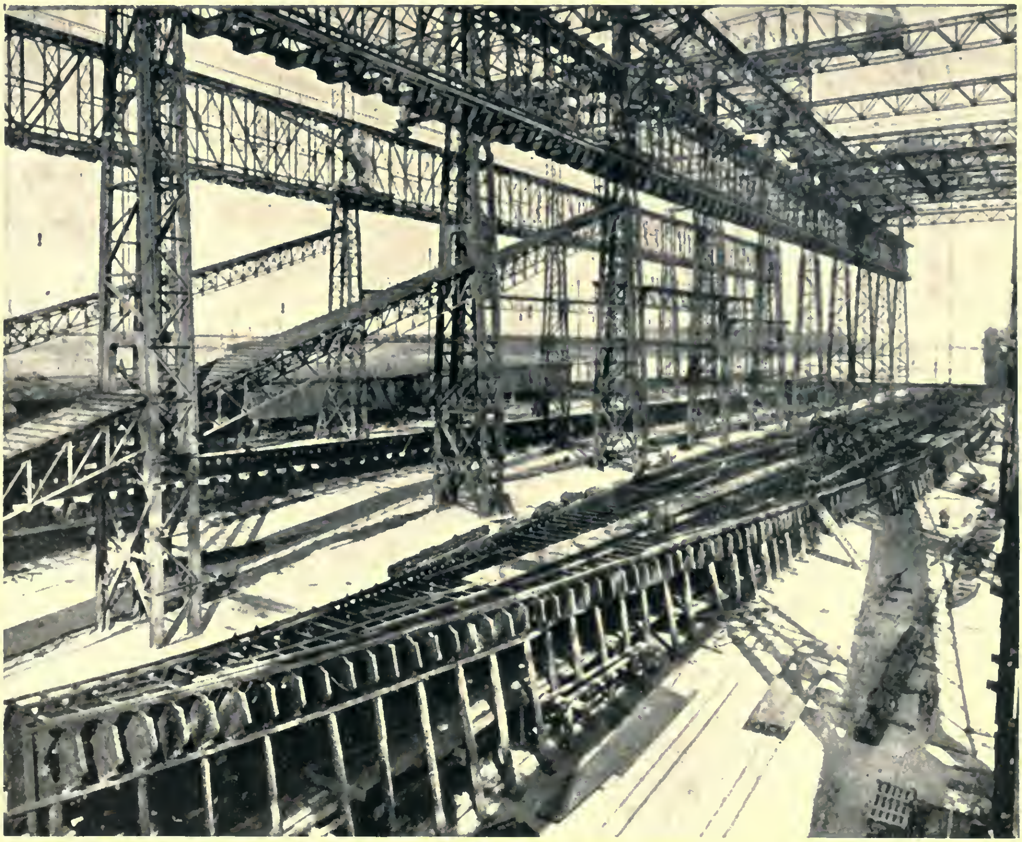


WHEN THE ARCHITECT HAS DESIGNED A BIG SHIP, THE VARIOUS PARTS ARE DRAWN FULL SIZE ON THE FLOOR OF A HUGE ROOM SUCH AS THIS

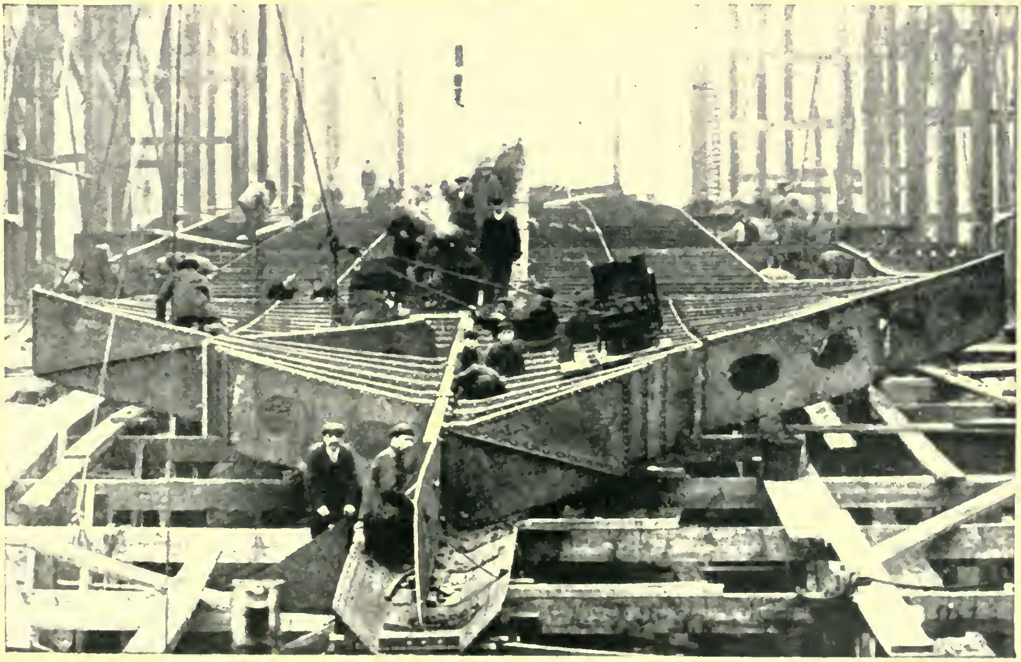


WOODEN MODELS ARE MADE FROM THE DRAWINGS OF THE SHIP, AND FROM THESE THE IRON AND STEEL PARTS ARE CAST

THE DOUBLE FLOORS OF A FLOATING PALACE

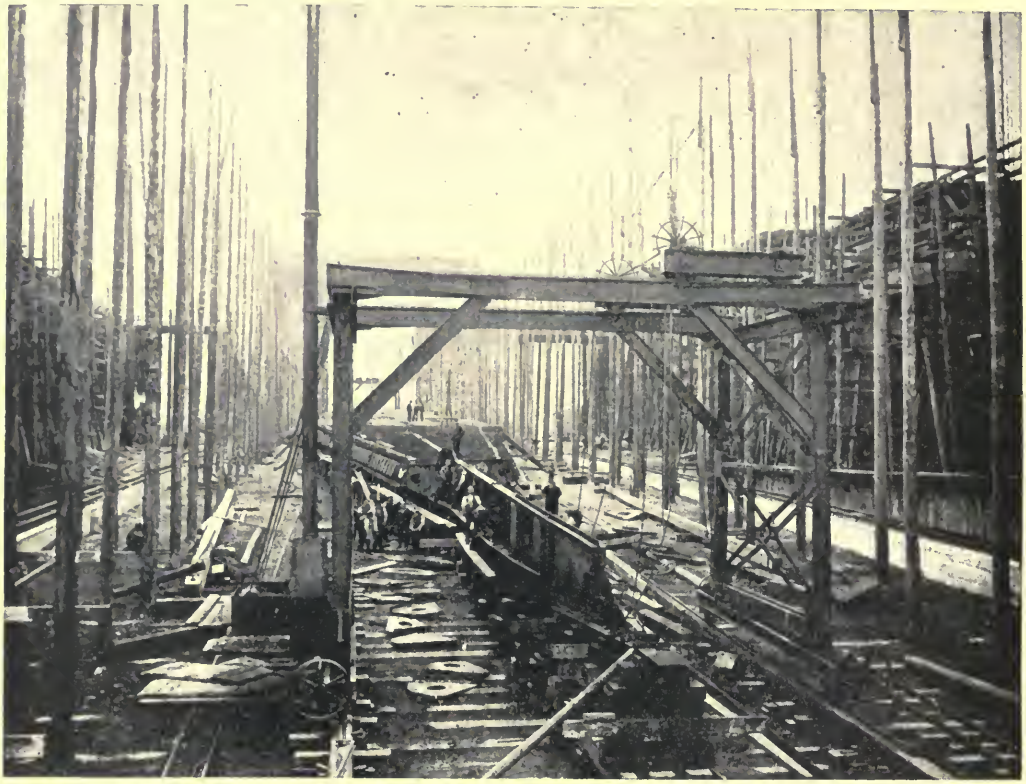


THE IMMENSE DOUBLE FLOOR OF THE OLYMPIC BEING BUILT UP ROUND THE KEEL

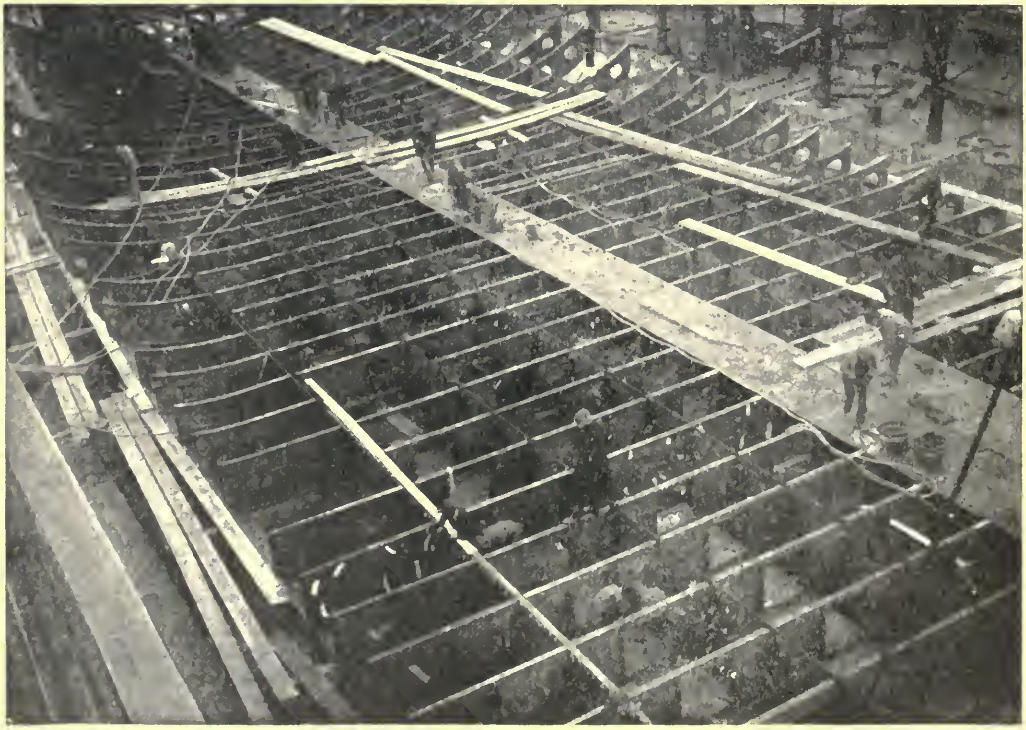


LAYING THE DOUBLE FLOOR OF ONE OF THE GREATEST SHIPS AT SEA

THE GREAT FLOOR THAT CARRIES 50,000 TONS

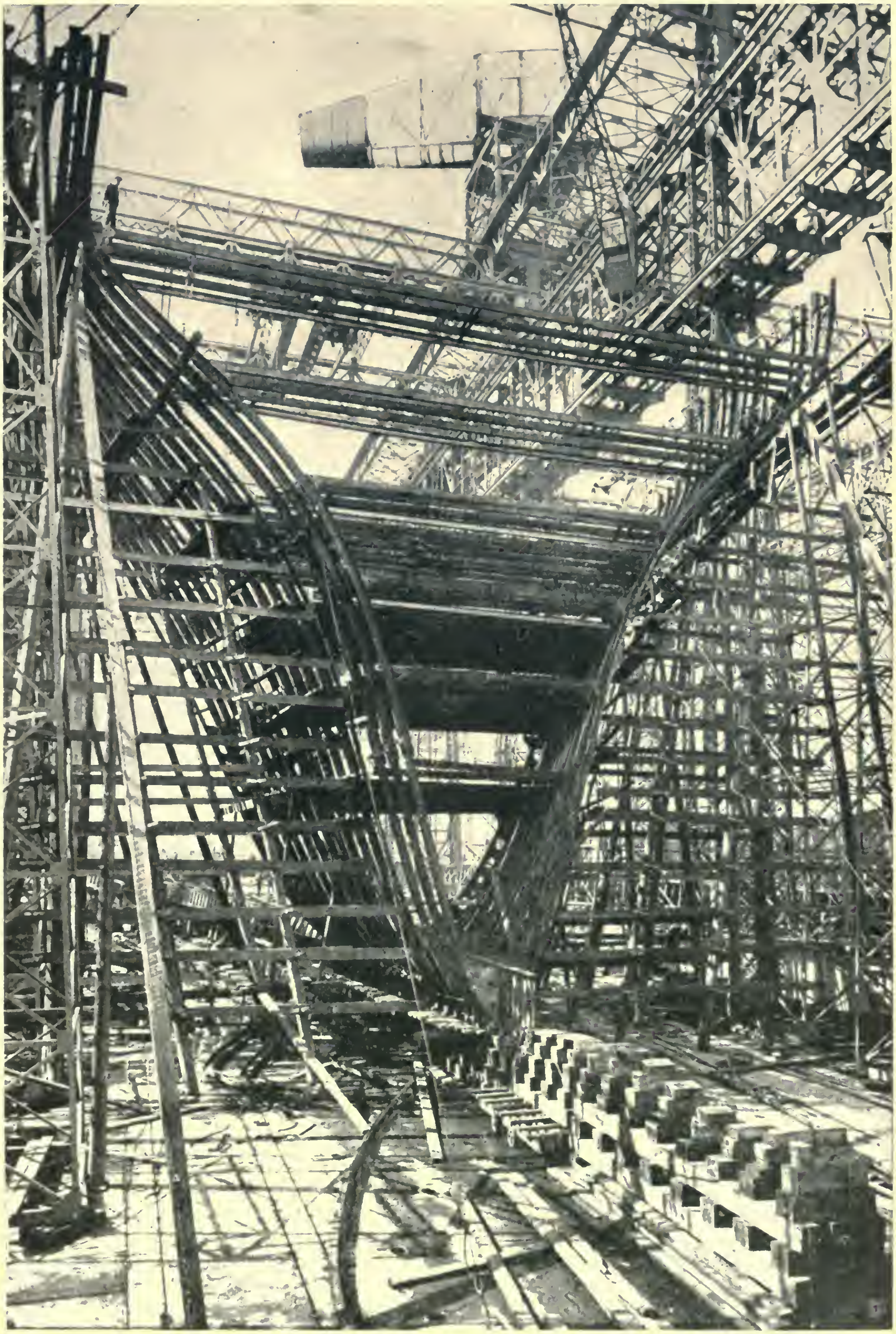


BUILDING THE KEEL OF THE OCEANIC ROUND THE LONG PLATES RUNNING FROM END TO END OF THE SHIP



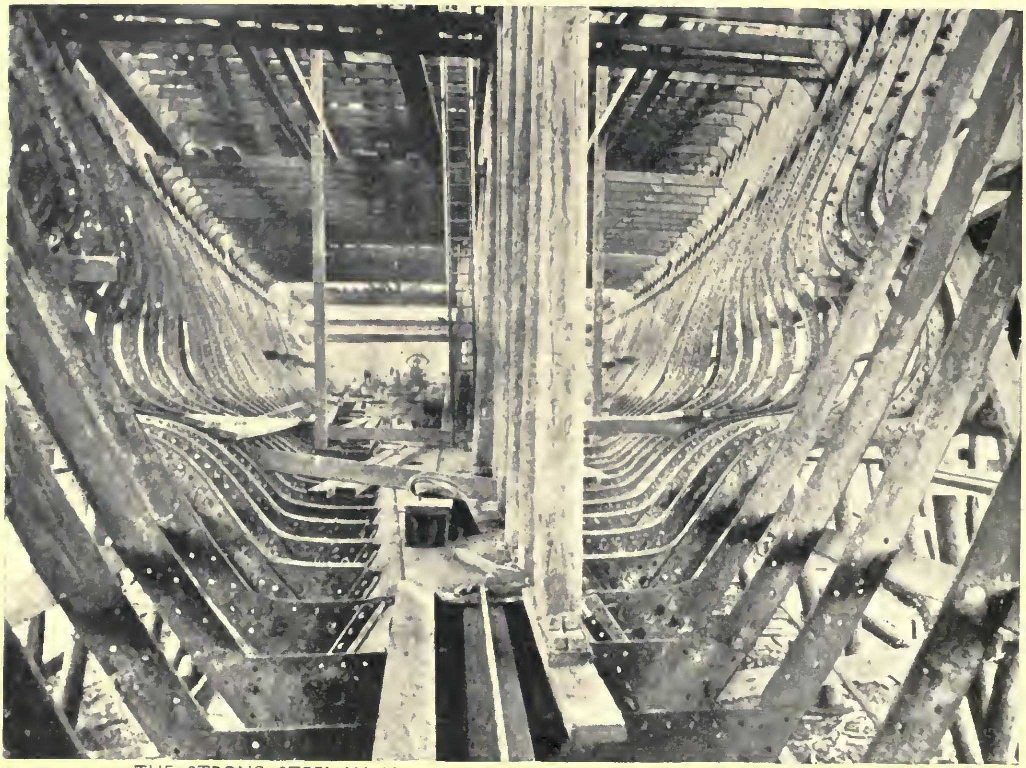
THE STEEL FLOOR BUILT AROUND THE KEEL-PLATE, CAPABLE OF CARRYING 50.000 TONS

THE STEEL SKELETON OF AN OCEAN GREYHOUND

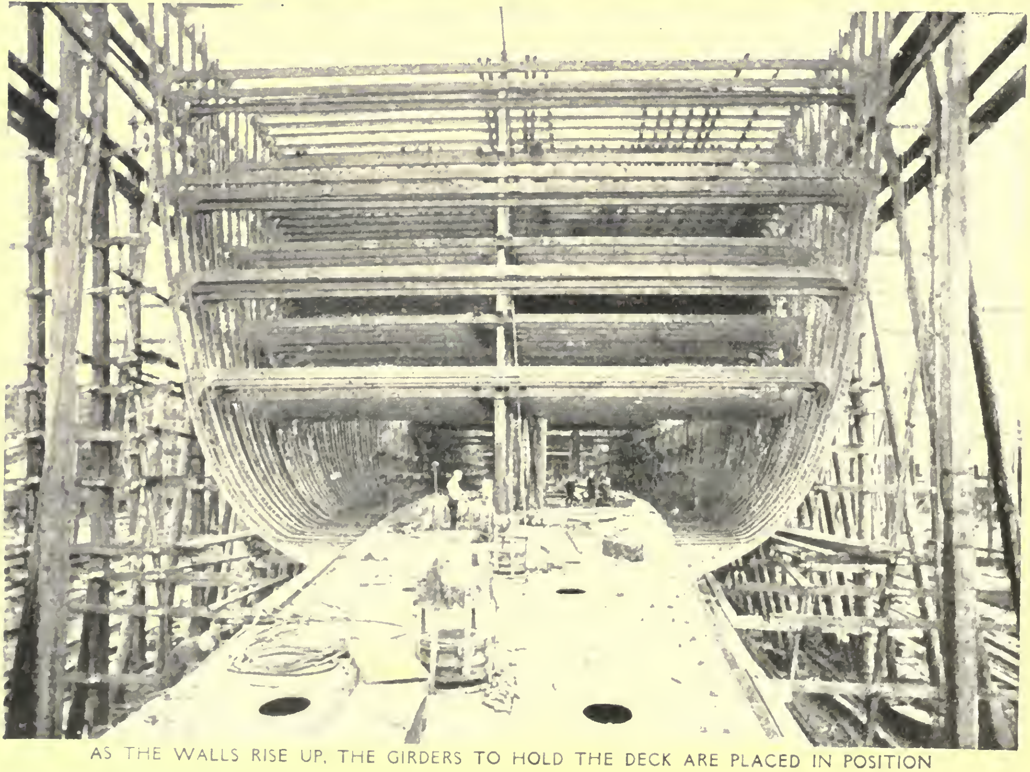


THE FRAMEWORK AND DECK-GIRDERS OF ONE END OF THE OLYMPIC, SISTER SHIP OF THE TITANIC

THE GREAT STEEL WALLS OF THE SHIP RISE UP

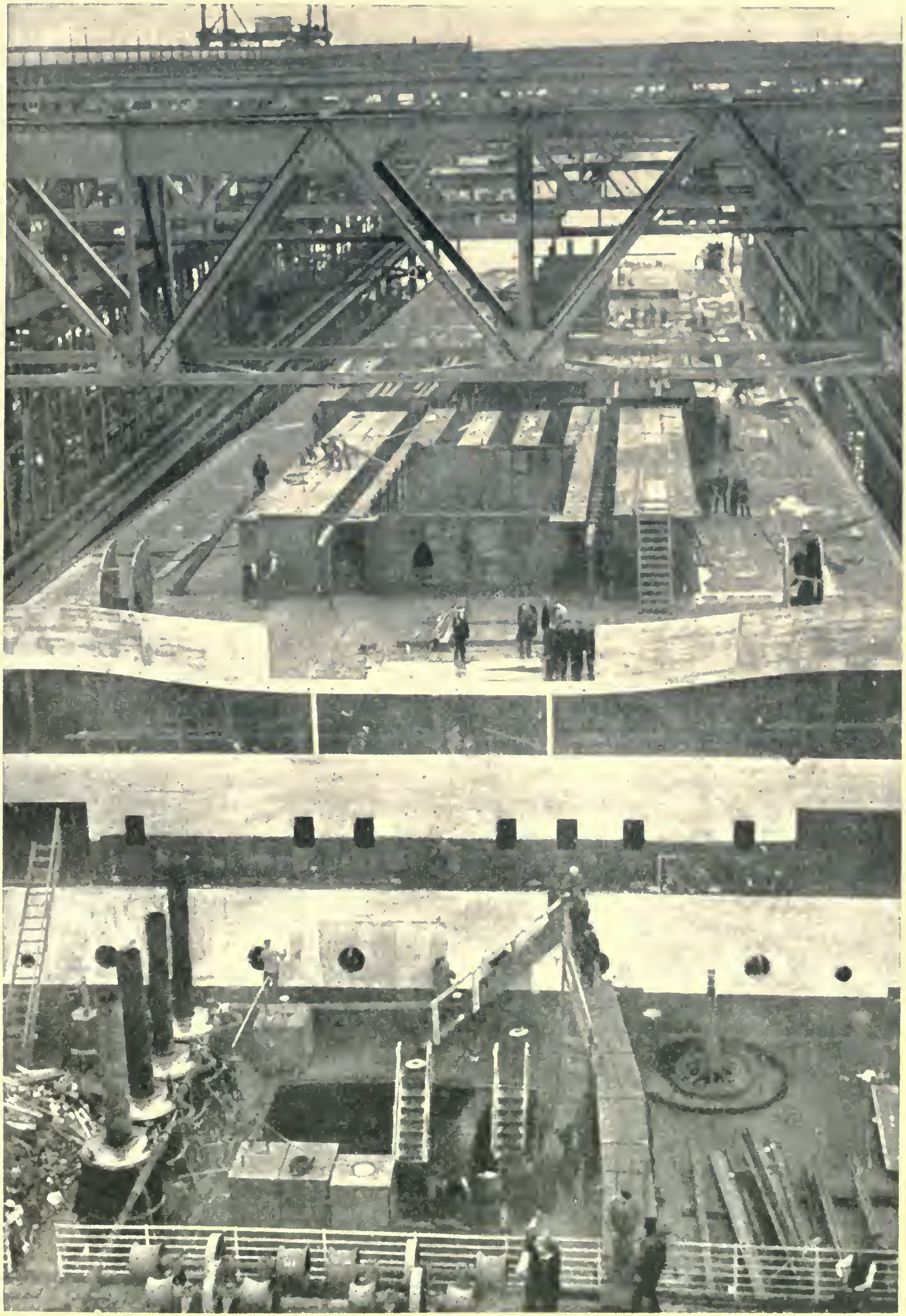


THE STRONG STEEL WALLS OF THE SHIP ARE BUILT UP FROM THE KEEL



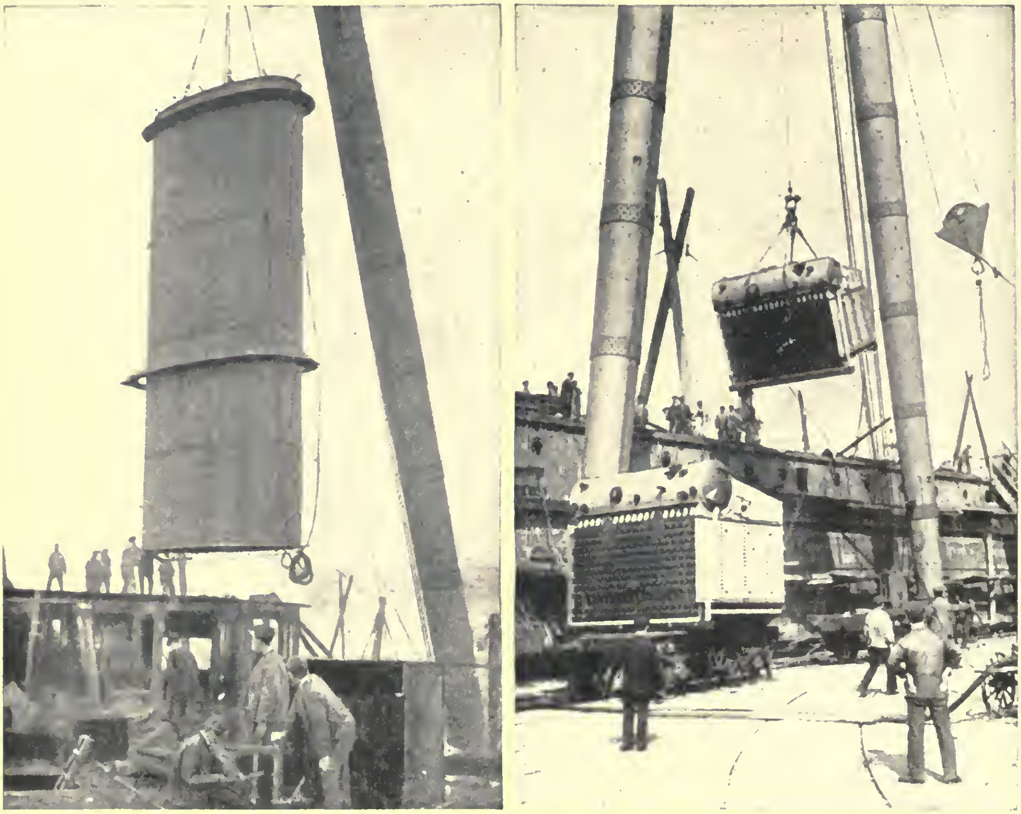
AS THE WALLS RISE UP, THE GIRDERS TO HOLD THE DECK ARE PLACED IN POSITION

LOOKING THROUGH A SHIP FROM END TO END

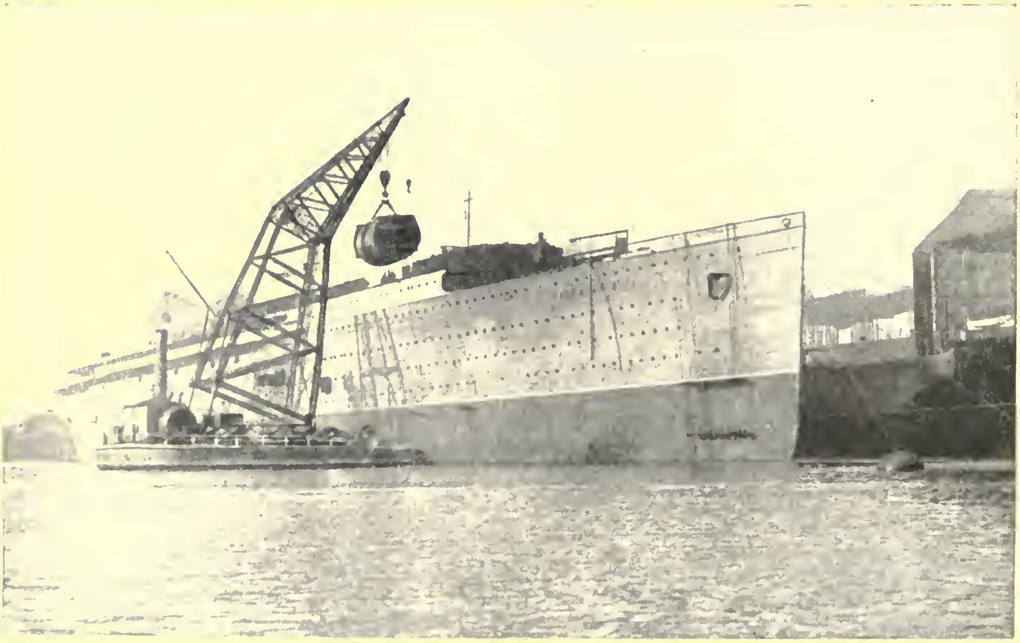


WE ARE NOW LOOKING THROUGH THE OLYMPIC FROM END TO END, SEEING THE DECKS ONE ABOVE ANOTHER. IN FASTENING TOGETHER THE STEEL PLATES OF THIS VESSEL, BETWEEN FOUR AND FIVE MILLION STEEL RIVETS WERE USED, WEIGHING NEARLY A THOUSAND TONS

THE STEAM BOILERS OF THE MAURETANIA

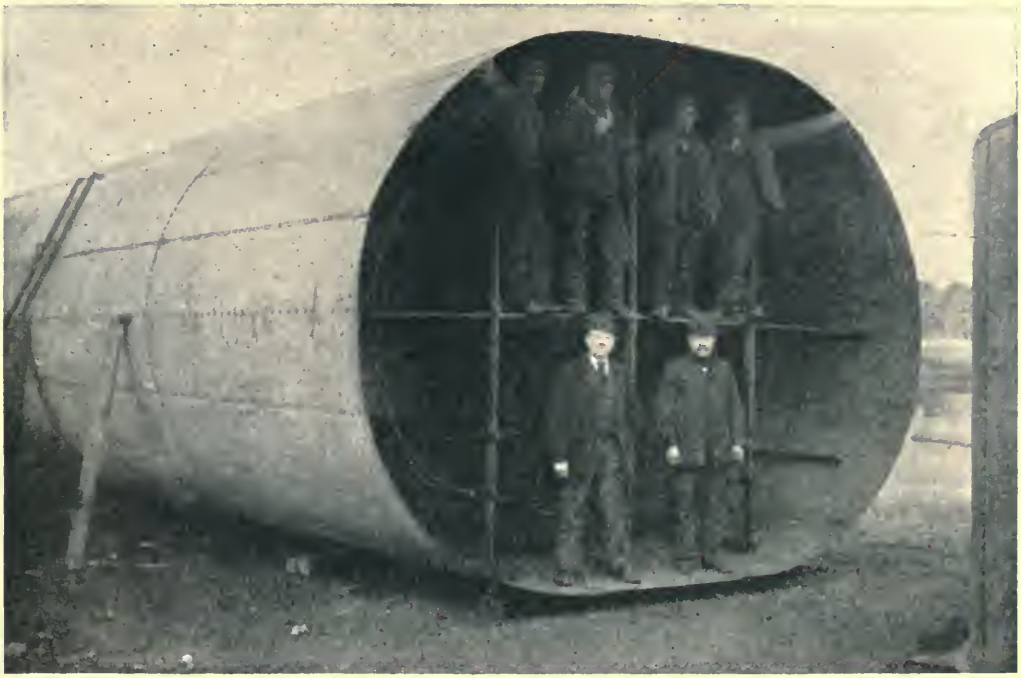


THE MACHINERY AND FITTINGS ARE ALWAYS PUT ON A SHIP AFTER IT IS LAUNCHED. HERE WE SEE A DREADNOUGHT'S FUNNEL GOING ON BOARD

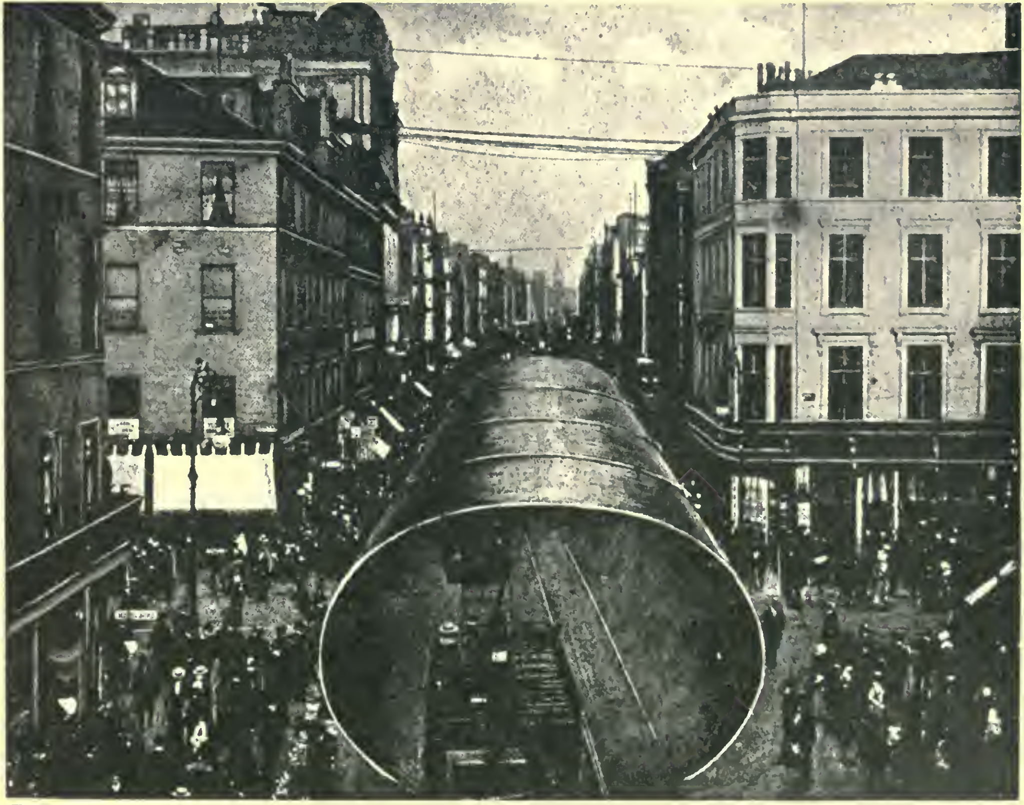


DELIVERING ONE OF THE 25 HUGE BOILERS TO THE MAURETANIA, WHOSE BOILERS HAVE A TOTAL HEATING SURFACE OF NEARLY FOUR ACRES

THE TREMENDOUS FUNNELS OF A GREAT SHIP

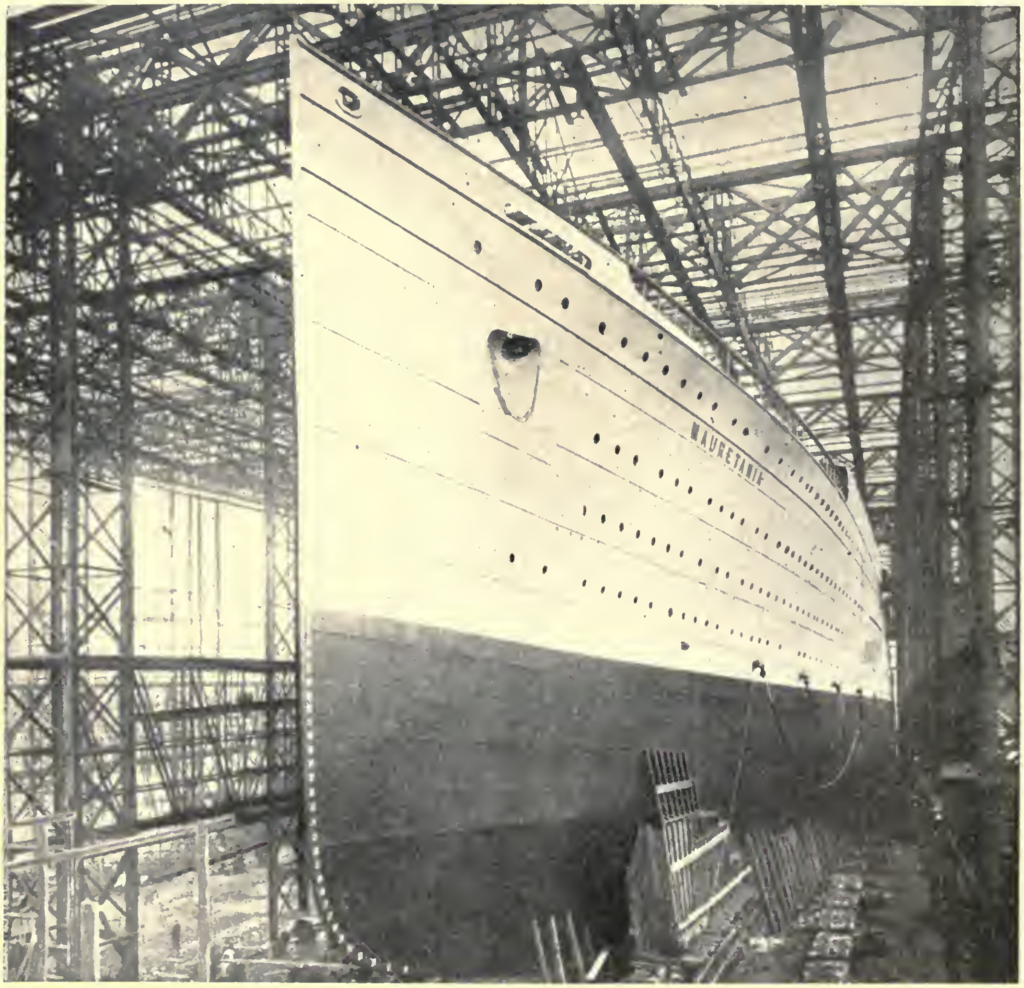


THE FUNNEL OF A DREADNOUGHT READY TO GO ON BOARD, WITH AN IRON STAIRCASE INSIDE, UP WHICH SEAMEN MAY CLIMB TO A PLATFORM RUNNING ROUND THE TOP

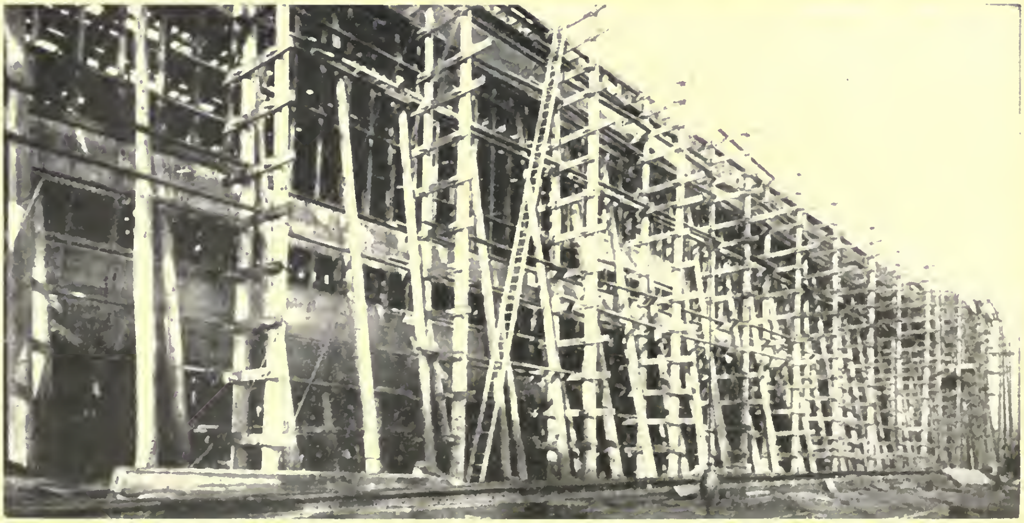


THE MIGHTY FUNNEL OF A CUNARD LINER, EVEN BIGGER THAN A WARSHIP'S, WITH ROOM ENOUGH FOR STREET CARS TO PASS THROUGH

IN AND OUT OF THE SHIPBUILDING SHED

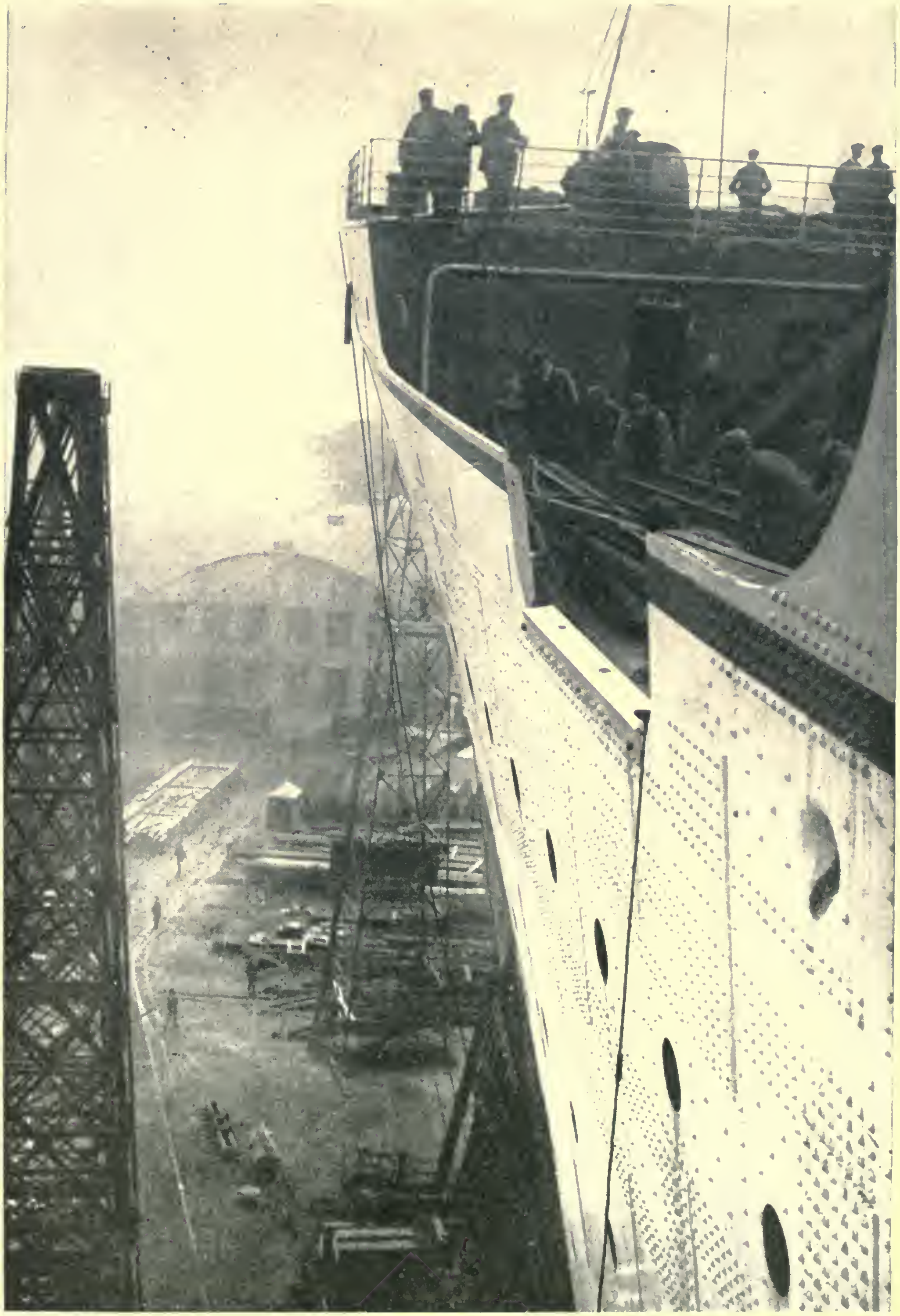


INSIDE THE SHED, WITH THE MAURETANIA NEARLY FINISHED AND READY FOR LAUNCHING



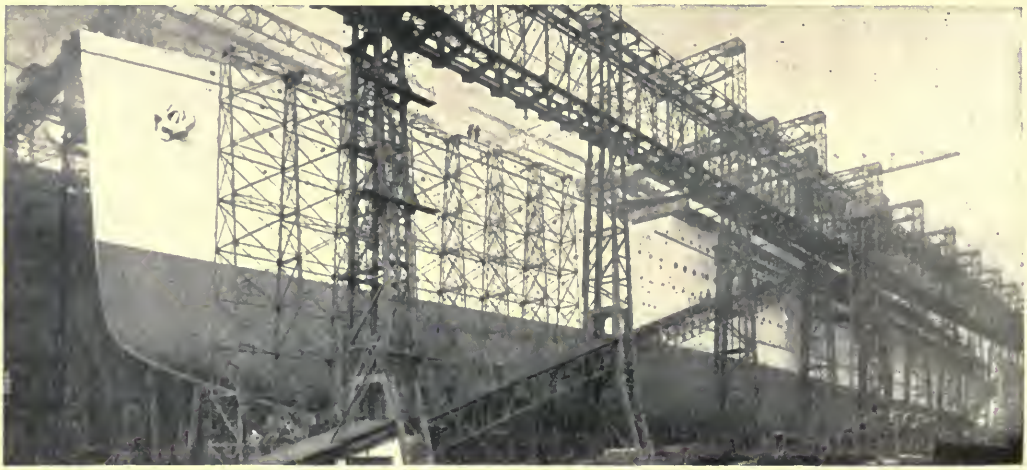
THE OUTSIDE OF THE GREAT SHED IN WHICH AN ATLANTIC LINER IS BUILT

THE PROUD SHIP THAT HOLDS ITS HEAD HIGH

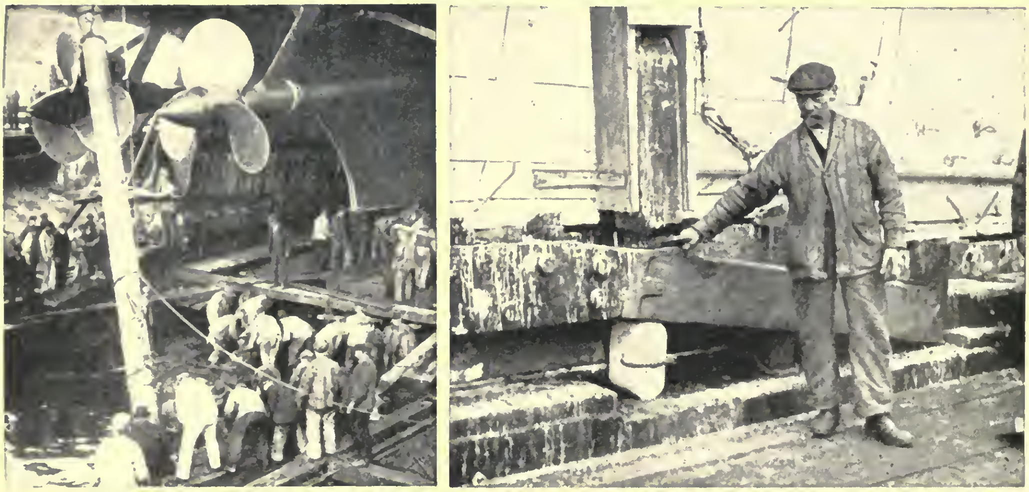


THE IMMENSE HEIGHT OF THE MODERN FLOATING PALACES IS CLEARLY REALISED FROM THIS PICTURE OF THE OLYMPIC STANDING IN THE SHIPYARD. FROM THE KEEL OF THE OLYMPIC TO THE TOP OF THE FUNNEL IS 175 FEET, AS HIGH AS A FIFTEEN-STOREY BUILDING

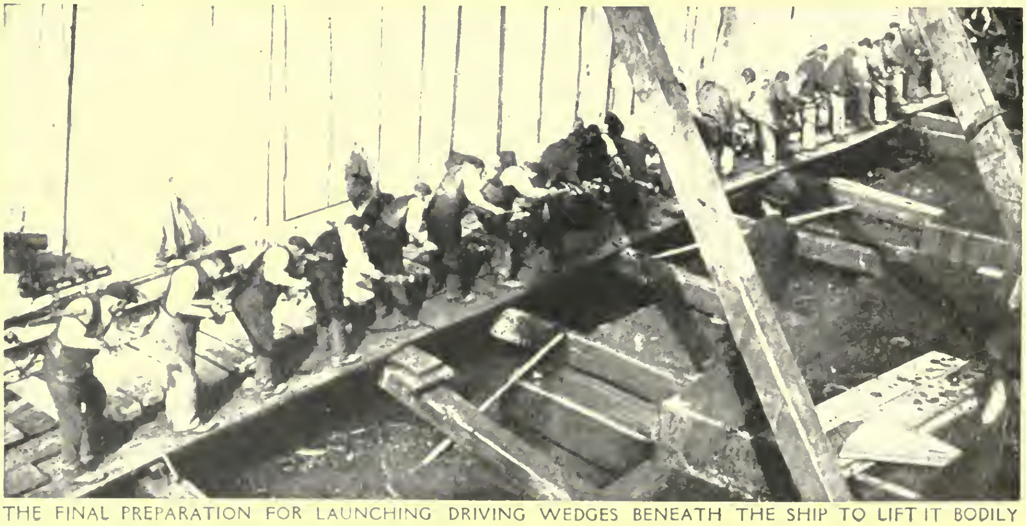
THE OLYMPIC PREPARES FOR ITS GREAT DAY



THE OLYMPIC, BUILT AND PAINTED AND READY TO BE LAUNCHED

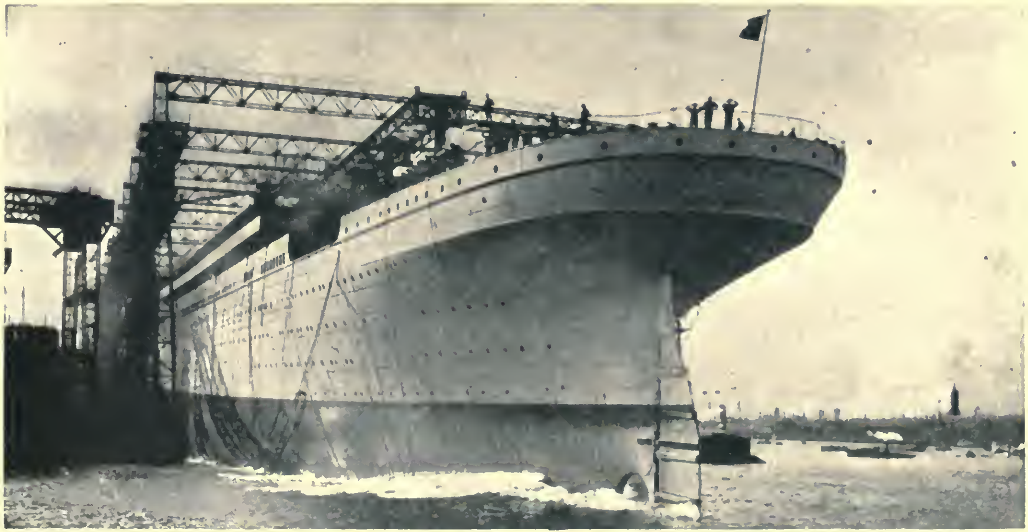


ON THE LEFT THE MEN ARE REMOVING THE LOGS FROM BENEATH THE SHIP; AND ON THE RIGHT IS THE CORD WHICH, WHEN CUT, WILL MOVE CERTAIN MACHINERY AND RELEASE THE SHIP

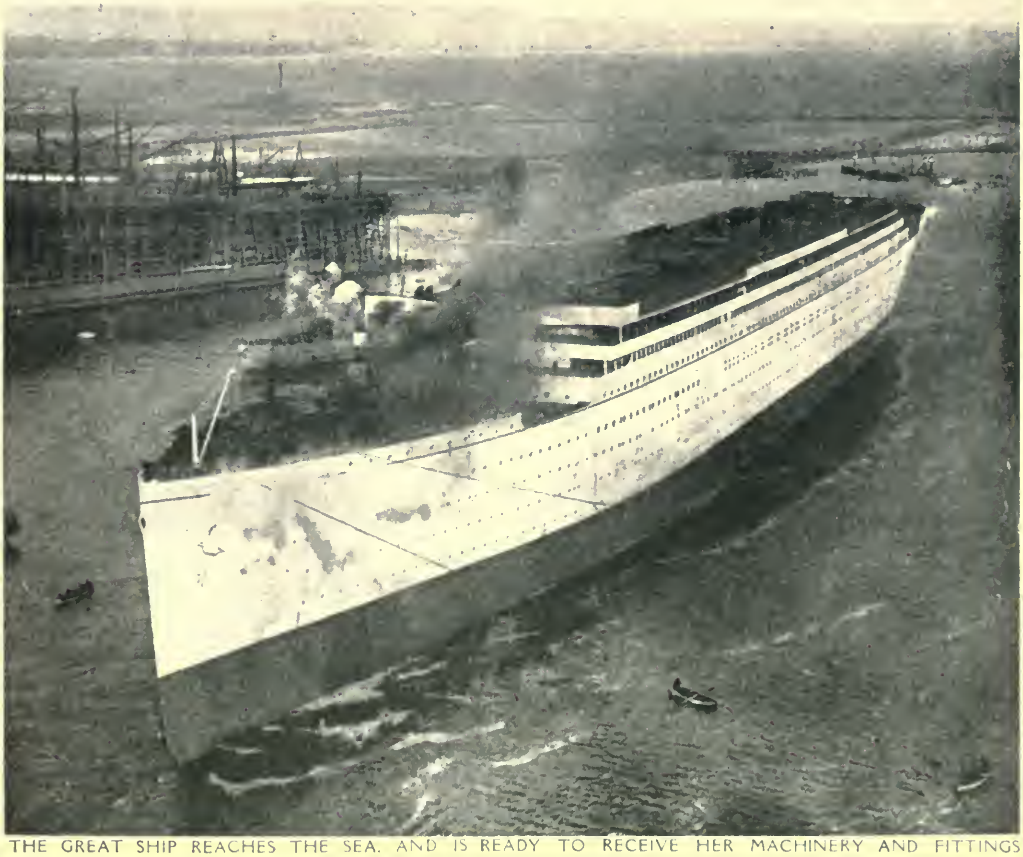


THE FINAL PREPARATION FOR LAUNCHING DRIVING WEDGES BENEATH THE SHIP TO LIFT IT BODILY FROM THE BLOCKS ON WHICH IT HAS BEEN BUILT

THE GREAT SHIP TAKES THE WATERS



HERE THE OLYMPIC IS SLIDING DOWN INTO THE SEA, OVER THE "WAYS," WHICH HAVE BEEN MADE SLIPPERY WITH THOUSANDS OF DOLLARS' WORTH OF GREASE AND SOAP



THE GREAT SHIP REACHES THE SEA, AND IS READY TO RECEIVE HER MACHINERY AND FITTINGS

Many of the photographs in these pages were obtained by the courtesy of Messrs. Harland and Wolff, and of Messrs. Swan, Hunter, and Richardson, shipbuilders.

THE LADYBIRD HUNTERS IN THE MOUNTAINS

MULES DRAG THE LADYBIRD HUNTERS UP THE PINE-CLAD SIDES OF THE STEEP SIERRA NEVADAS, AND HERE THE MEN GATHER THE LADYBIRDS IN MILLIONS WHEN THEY ARE FAST ASLEEP

A MIGHTY ARMY FAST ASLEEP

HOW HUNDREDS OF MILLIONS OF LITTLE RED SOLDIERS ARE CAPTURED AND SET FREE TO FIGHT FOR MANKIND

ONE OF THE MOST WONDERFUL TALES IN THE WORLD

LAST autumn a pretty little ladybird settled down for her winter sleep in the mountains. She slept a much shorter time than usual, for the warmth of spring, apparently, came very early in the year. Very strange and mysterious was the place in which she found herself. It was pitch-dark, like a sort of deep underground tunnel. But far away was a faint gleam of light; and, still rather drowsy from her sleep, the ladybird began slowly to crawl down the dark passage towards the far-off gleam. As she advanced, the light naturally grew brighter. This made her in turn feel livelier, and she hurried forward as fast as her little legs would carry her.

By this time, many other ladybirds in the strange and unknown dark place were struggling to get out into the light.

There were hundreds of thousands of them ; but the passage grew so narrow that at last they were able to move only in single file. In bustling along, they shook from their feet and wings the earth and moss in which they had been sleeping, so that they were nice, clean little creatures when they came to the end of the passage.

Our ladybird took her place in the long, thin red line, scrambling along with all her might. But when she reached the edge of the track, and was about to come, joyful and radiant, into the warm light, an accident occurred. The passage ended in a blank precipice, and, pushed forward by her comrades, the ladybird tumbled through the air. Naturally, she stretched out her wings, and she alighted without damage on the top of a great heap of other ladybirds.

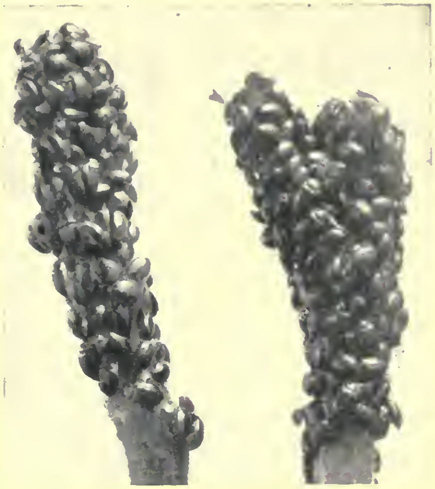
"Shut down the passage for a minute," said a human voice. "This one, I think, makes up the box.

The fact was that, in running from their strange prison towards the light at the end of the passage, the ladybirds went into a counting machine placed immediately under the hole through which the light had shone into their prison-house. Pouring down into the scale in a stream of bright, flashing little bodies, they were counted and put into boxes, about one foot square and eight inches deep, to be sent to the farmers of California. The sides and the end of the box were made of thin boards, but the top and the bottom were of wire netting, so that the little ladybirds could obtain plenty of air on their journey.

When the ladybirds have been cleaned and packed into boxes, they are sent to sleep again. This is done by putting them into a wintry cold room. The coldness makes them drowsy, and they soon settle down in quiet slumber. It is sometimes five months before they are brought into a warm room and allowed to awake. All this time no food is given to them. So they are the hungriest creatures in the world when the California State Insectary sends them to the fruit-growers of the Imperial Valley and other places in the country. There are about 33,000 of them in a small box, and when the farmer receives them his face beams with happiness. If they come in the evening, he goes out at once with his box of ladybirds. Hurrying into his fields and orchards, he opens the box and allows the hungry little things to escape from their long imprisonment. Away they go in a cloud, thinning out and scattering in the warm evening summer air.

"I reckon I shall have a good harvest this year," says the farmer, as he returns to his house for supper. "I have let the ladybirds out, and I fancy there won't be many plant-lice left on the farm to-morrow night."

And there are not. The pretty little ladybird is, in her way, as fierce and terrible a creature as a tiger. She is an insect of prey, swift, eager, and ravenous. Happily, she does not like fruit or greenstuff. She lives entirely on the small plant-lice of California, which are somewhat similar to the green-flies that do such damage to the rose-trees of Great Britain. Now, these plant-lice are the plague of the Californian farmer. They eat up his melon beds and his cucumber beds, and turn his apple and pear orchards into wastes of blighted trees. The melon-growers of the Imperial Valley used to lose millions of dollars in produce every year through the attacks of plant-lice. In vain did they spray their growing plants with all the poisons science could invent for the destruction of the green pest. The insects could not be kept down. They came suddenly, and would ruin a field in three or four days. The only possible way of getting rid of them was to burn the vines they had attacked.


LADYBIRDS CROWDED TOGETHER ON THE TIPS OF TWIGS

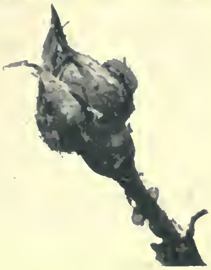
Such was the state of things when the men of science at the California State Insectary, in Capitol Park, Sacramento, thought of the pretty little ladybird. In the warm climate of California the ladybird awakes from her winter sleep in January. In the natural order of things she flew down from the mountains just in time to prey upon the plant-lice before they had begun their work of destruction on the vines and fruit-trees in the valleys below. But the Californian farmers have altered the natural conditions of agriculture, and, by a new system of watering and cultivation, they bring their vines fully out in April and May. The plant-louse now waits till its supply of food is ready, and then, in enormous multitudes, it sets to work and devours the juices of the growing plants, crumpling up and withering the leaves, like a sort of blight.

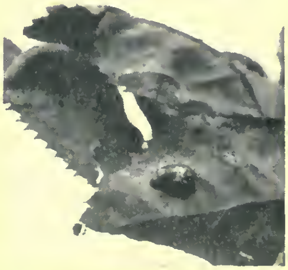
THE LADYBIRDS COLLECTED ON A SHRUB

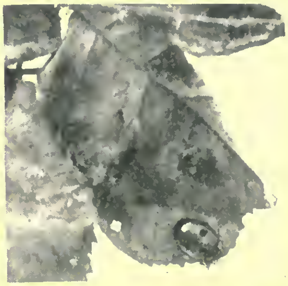
The result of this change in seasons is that the plant-lice are no longer kept in check by their natural enemy, the ladybird. For months the hungry ladybird has been winging her way over field and orchard seeking for her prey, but the plant-lice have been so few that the ladybirds have nearly all died of starvation by the time the farmers need their help. The plant-louse feeds away, with no one to disturb it at its feast, and then it begins to reproduce enormous numbers of young ones. In a few days whole fields of cantaloupes, cabbages, cauliflower, and other vegetables, and large orchards of prunes, apples, and pears, are completely ruined, causing a loss of millions of dollars. In one cantaloupe field alone one hundred acres of healthy green vines were destroyed by plant-lice in three days.

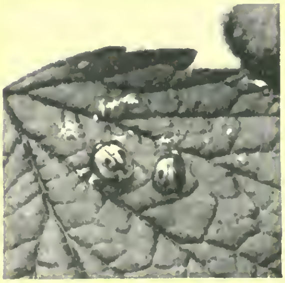
The evil became so great at last that some years ago the University of California and the State Commission of Horticulture appointed Mr. E. K. Carnes to study the problem of the plant-louse. After examining the widespread damage done by the pest, Mr. Carnes told the farmers and fruit-growers that they could preserve their crops by collecting ladybirds and setting them to work on the fields. The growers laughed at the man of science. There were not sufficient ladybirds in the United States, they said, to clear the fields and orchards of the pests. But Mr. Carnes, who is the superintendent of the State Insectary, knew what he was talking about. For months he had studied the ladybird. He had carefully watched her during all the stages of her life, and he was certain that she was a wonderfully good mother, bringing into the world every season a swarm of a hundred and fifty young children. She was careful that they should be well provided for. When she found that plant-lice were abundant, she laid her eggs one by one, so that, when the baby ladybird was born, it could find its food without having to struggle with its brothers and sisters. Knowing all this, the superintendent felt certain that if he could get some ladybirds among the insects in April and May, the work of keeping down the pest would be accomplished.

LADYBIRD'S EGGS ON LEAF


THE YOUNG GRUBS APPEAR


GRUB BECOMES A CHRYSALIS


THE LADYBIRD EMERGES


THE LADYBIRD SEEKS A MATE

So he made arrangements for studying the winter habits of the little friends of the farmer. It was already known that small groups of ladybirds were to be found sleeping in winter on the high, snow-clad mountains of California. Mr. Carnes resolved to see if all the little creatures flew away from the warm valleys to the cold, white peaks when the turn of the year came. Taking with him two experienced field men, he began a long and wide search over the mountain heights.

Clambering over the rocks and wading deep in the snow, and shovelling away into the earth, he found that the ladybirds really did fly up to the mountains for their winter sleep. For he discovered large quantities of them, fully grown, but motionless and slumbering, securely hidden under moss and leaves and pine-needles, with a deep covering of snow above their winter quarters.

Two or three bagfuls of the sleeping little creatures were carried back to the Insectary in the town of Sacramento, and all that winter Mr. Carnes was busy making experiments with them. Some he woke up from their slumbers by putting them in a warm room. Some he allowed to wake up naturally in January, and fly over the city to the fields and orchards where few or no plant-lice had yet appeared. Most of the ladybirds, however, were placed in large, dark, icy-cold chambers, around which ran freezing currents of chemicals. Of course, sufficient air was admitted to enable the insects to breathe as comfortably as they did beneath the frost and snow of the high mountains, and the coldness was so adjusted as to correspond with the weather on the wintry mountain-tops.

The little sleepers had no idea of the strange adventures that had come to them; it was all like the dream of a ladybird, but it was true, and the ladybird didn't know. What Mr. Carnes wished to find out was whether he could keep the ladybirds in a healthy comfortable sleep through the hot spring-time, when the sun burns with a tropical splendour in the Californian valleys. Millions of dollars depended on the result of his experiment with the pretty insects, to whom most of us have at one time or another said:

Ladybird, ladybird, fly away
home,
Your house is on fire and your
children all gone.

In this case, the house of the ladybird was frozen, instead of being set on fire, and she was asked not to fly away, but to stay asleep until a telegram arrived from the Imperial Valley saying that the plant-lice were devouring the crops.

To the great joy of Mr. Carnes, the experiment was entirely successful. Winter passed away and spring came on, and the ladybirds continued to sleep in the cold-storage rooms; and it was found that, even when they had been kept in their cold slumber for seven and a half months after their usual waking time, they jumped up out of their sleep as vigorous and as lively as ever. It was quite easy to arouse them. For as the air of the room was gradually made warmer, they shook off their drowsiness, and were most eager to go in search of the wicked and destructive plant-lice.

So the great danger was completely avoided. What had happened was that the farmers had changed their season by methods of their own, and had found out their mistake too late; the plant-lice had the orchards to themselves because the ladybird came too soon. Now the ladybirds were to be caught in millions and kept asleep till they were needed, so that the ladybird season, too, was changed to suit the farmers. Even Mr. Carnes had been half afraid of the effects of keeping the ladybirds sleeping without food for some months after their natural period of awakening. All that the little creatures had to live on was the store of nutrition with which they had plumped out their tiny bodies during their feasts of the previous year. All the time they slept they were drawing on this reserve of strength, and, until an experiment was made, it was impossible to foretell if they would survive a long, artificial sleep, added to their ordinary winter slumbers.

THE LADYBIRD HUNTERS WITH A DAY'S CAPTURES

Happily, they did so, and the superintendent of the State Insectary sent the good news to the farmers. "In the coming spring," he told the anxious growers, "the Insectary will be able to provide you with ladybirds by the ton."

It was a bold prophecy, but it has been more than fulfilled, for the Insectary at Sacramento now ships crates upon crates of ladybirds to practically every county in the State of California. Growers of every kind of plant liable to attack by plant-lice now apply regularly for an army of their little friends, and the trees in cities and the plants in public and private gardens are all protected by little red policemen with sheathed wings.

All this has led to the creation of a great and strange industry centring in the State Insectary. On the first of November every year a band of field men goes exploring in the mountains. There they hunt for sleeping colonies of ladybirds. The sleepers are usually found among pine-needles on sunny, well-drained mountain slopes, close to a foaming torrent of running water. The sleeping-places are high up in the wild mountains, and the men who look for them have to work hard, and are continually exposed to dangers.

In the early part of November only a few ladybirds are discovered. They are the first arrivals, which for some reason or other have sought their winter quarters before the usual time. Even now the people living on the mountains refuse to believe Mr Carnes when he tells them that all the ladybirds sleep through the winter under the great snowy heights.

"Nonsense!" say the mountain settlers. "We use our own eyes, and we know. They only come up the mountains early in the spring."

The field men merely smile at these people, and continue their search for the sleeping places. They have nothing to guide them but a new kind of sense that has gradually been born of experience. They can at once tell where ladybirds are likely *not* to be, and by this means they save themselves the trouble of scouting over a great deal of unproductive territory. When at last they discover a colony, they dig into the pine-needles and moss and leaves; and from past experience they are able to estimate how many pounds the colony will yield when all the ladybirds still flying about the valleys have come to their sleeping-places. Mr. Carnes has found that the early arrivals, when they nestle down in their winter quarters, give off a scent which attracts all the other ladybirds that are seeking for a shelter. Once a colony is started, it grows in number with astonishing rapidity.

The field men are only concerned to find the beginnings of each colony. They then draw on a card a little map of the spot, and cut marks on the neighbouring trees. On the back of the card the scout states the probable number of ladybirds that will join the colony, and the conditions of the place, and any other information likely to be useful in the depth of winter, when the real work of collecting ladybirds by the ton is undertaken. The work of scouting extends to many of the mountainous districts of Northern California, until sufficient colonies of ladybirds have been located.

The real work of collecting starts late in December, and continues till late in February. The field men again go into the mountains, and set up a central camp, from which operations are conducted. They are provided with plenty of thick clothing, heavy gloves, and rubber shoes, for they are exposed to the severest cold, and must tramp long distances through deep snow. When practicable, a mule is taken along from the camp to carry the ladybirds, two men usually working together, and with fairly good fortune they will collect from 50 to 100 pounds of ladybirds in a day.

The insects are bulky in proportion to their weight, and a mule cannot very well carry more than 125 pounds of them. More often, however, the colonies are so inaccessible and so far off from the mountain trails that they are carried by the field men themselves into camp, slung in sacks over their shoulders. The trails in the high Sierra are usually so steep and the footing so precarious that riding is dangerous, and the men generally prefer to go on foot. If a saddle mule be taken on such an expedition, it is allowed to go first, and the field men get the animals to pull them up the steep slopes by hanging to their tails.

As the colonies are buried beneath several feet of snow, it would not be possible to find them but for the maps previously made on the card. The collectors have to travel over trackless wastes among the mountain peaks, making bridges across swollen streams by felling trees. In many cases they find themselves taking a sudden ice-cold bath, with two heavy sacks of ladybirds hanging round their necks and the camp miles and miles away. From the camp the ladybirds are sent to a railway station, and there the colonies of insects, still fast asleep in the sacks, are awakened and attracted down a passage into a counting machine. It is a brief, strange awakening, for almost at once the ladybirds are packed in dry litter in airy boxes and sent to sleep again.

COUNTING AND PACKING THE LADYBIRDS

For six months, or less, the sleeping ladybirds have to be kept in a state of suspended animation, so they are sent from the mountain packing-house to a large cold-storage room in Sacramento. The air must be kept cold and slightly moist, and the ventilation must be perfect. From April to June in each year letters and telegrams arrive from farmers asking for supplies of ladybirds. The boxes are then taken out of the cold-storage rooms, and by the time the farmer's little friends arrive by express delivery at the farms they are awake and hungry, and eager to attack the plant-lice. In the spring of 1912 many millions of the pretty creatures were despatched to farmers in various parts of California, and the result was an unusually abundant harvest of melons, plums, apples, pears, vegetables, and garden produce. Already the Californians are wild with delight and full of gratitude for the services performed by their little winged protector. Nothing that the science of man can invent is as good for the crops as the victory of the ladybird over the destructive plant-lice.

It is expected that next winter the work of re-collecting the ladybirds will be much less troublesome, for Mr. Carnes has been studying the wintering habits of the little creatures, and has discovered many wonderful things about them. He now knows why they go up into the mountains to rest, and what brings them together in colonies to sleep. It appears that in the autumn a strong and steady current of wind sweeps through the valleys of California, and then rises up the slopes of the northern mountains. The winds surge up the ravines, which form a kind of funnel below the summit of the snow-clad heights. It is at the end of this funnel that tons of ladybirds are found sleeping beneath the snow. They travel on the wind, thus saving themselves the labour of making long journeys by wing power alone; and when the currents of air clash and eddy together in the mountain, the ladybirds alight and search for their winter beds. Mr. Carnes and his helpers can find these beds now almost as well as the ladybird can. He has collected seven million ladybirds in a spot where not a single one was visible.

THE COLLECTORS BRINGING THE CAPTURED LADYBIRDS DOWN FROM THE MOUNTAINS

The fact is that ladybirds have a distinct smell—strong, but not displeasing. They can sometimes recognise one another half a mile off, merely by the sense of smell. And as the places they have slept in the winter before still retain somewhat of the odour of their little bodies, they make at once for these spots when they finish their journey on the wind to the mountain peaks. The smell saves them the trouble of searching for a safe and comfortable sleeping-place.

Most of the ladybirds are young and inexperienced creatures, born that season in the valleys. They have no knowledge whatever to guide them in their migration to the northern heights. It is simply their strange responsiveness, first to the wind, and then to the smell of the ancient winter quarters of their race, that leads them to pass the winter in the same spot as their dead ancestors. Then, in the ordinary way, they would all wake up at the same time, and fly to their old feeding-ground in the southern valleys; but here the new ladybird hunters arrive upon the scene, and carry them off to their new world.

Mr. Carnes has followed them in their returning flights for ten miles down the ravines. The air was filled with a cloud of swiftly moving ladybirds, so dense that it was very annoying to be among them. Many of the little flying creatures could not get out of the way; they struck against Mr. Carnes and alighted upon him, covering him with their little red bodies. He was very glad when the ravine opened out and gave them more room in which to fly. Yet this strange experience shows that there are enough ladybirds wintering in the mountains of Northern California to look after all the fields and orchards of the American farmer. In a few years the destructive plant-louse will be entirely kept in check by the little red policemen with wings.

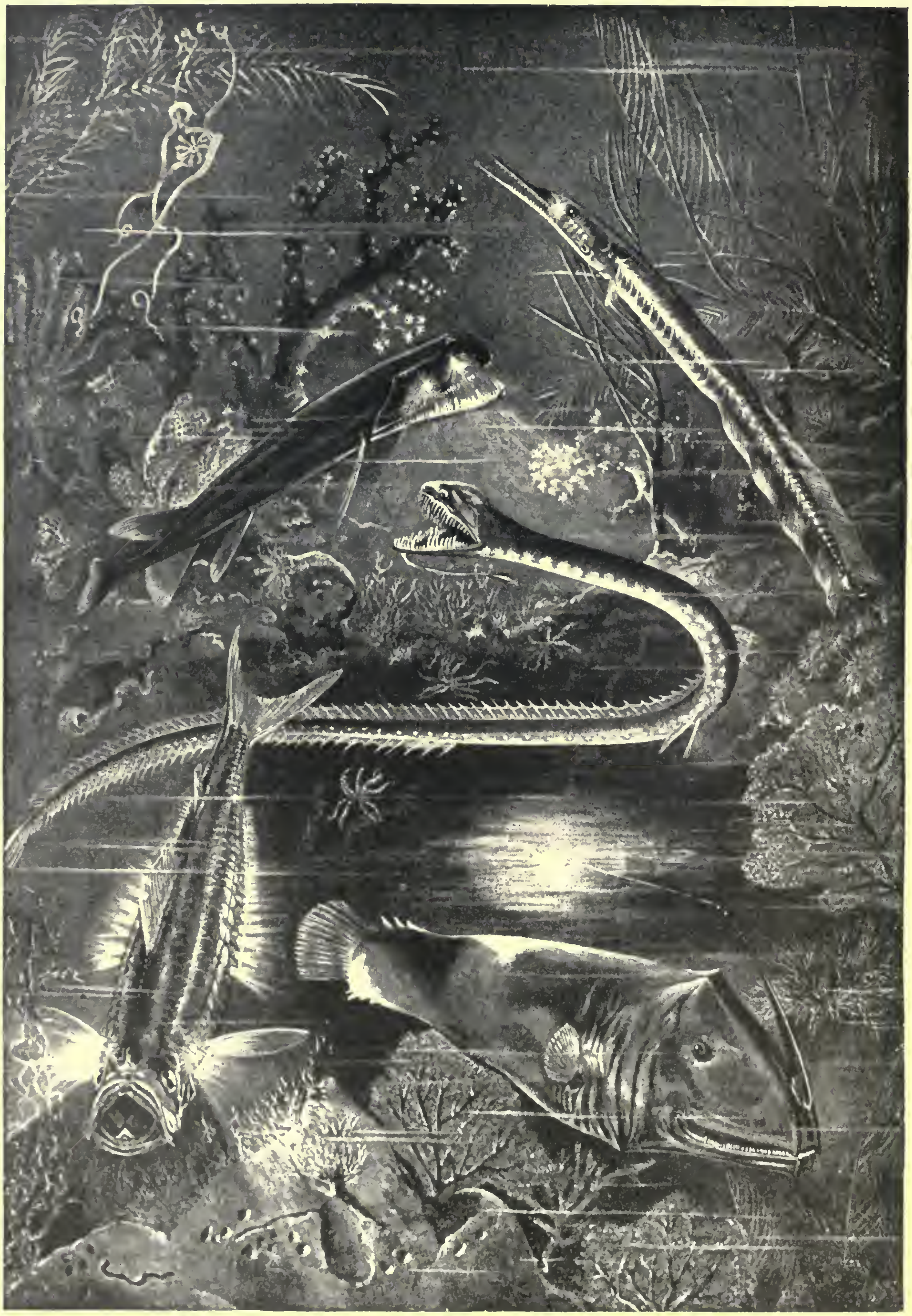
WHERE LADYBIRDS SLEEP & WHERE THEY WAKE

A SUMMER SCENE IN AN ORCHARD SAVED FROM RUIN BY LADYBIRDS CAPTURED IN WINTER SNOWS

A WINTER SCENE IN THE SIERRA NEVADA MOUNTAINS, WHERE THE LADYBIRDS ARE CAPTURED FAST ASLEEP

© H. C. White Co.

THE LIVING LIGHT OF THE OCEAN DEPTHS



No man has been to the depths of the ocean in which such strange creatures as these live; but we know that the beds of the seas are often illumined like the streets of a city at night by the phosphorescent fishes which live in these great depths.

THE EXPLORERS OF THE OCEAN BED

A PEEP INTO THE EDGE OF A KINGDOM OF LIFE WHICH NO MAN HAS EVER SEEN

WHAT IT IS LIKE MILES DEEP IN THE SEA

CAN you imagine a creature, not as big as a man, easily supporting on its body a weight equal to twenty railway trains loaded with iron bars? It seems impossible that such a creature can exist. But, as a matter of fact, there are millions of such creatures. At the seaside this summer we may peep into the edge of the strange and marvellous kingdom of life where they dwell.

We may peep into just the edge of this kingdom, but there are men living who explore the breadths and depths of this vast home of unseen life. Looking at it from the shore, the sea does not seem to be very mysterious. Few persons would ever guess that the wide, blue surface of foaming water conceals a weird and wonderful country of life, the realities of which far surpass our wildest dreams—or nightmares. We know, of course, that there are fishes and other creatures swimming about the underworld of water; but what we can see of the ocean, as we lean over the side of the boat or stand by the edge of the shore, does not tell us anything about the real kingdom of the sea.

Slowly men are exploring the depths, but even the diver cannot catch a glimpse of the country of mystery which is buried beneath the waves. No diver has ever been able to descend more than two hundred and eighty-eight feet below the sea-level; yet the ocean is in places six miles deep. Man has scaled the skies, and mined for miles into the earth, but the deep sea checks him. No diver has yet descended more than ninety-six yards below the waves—ninety-six yards out of ten thousand—and even this little journey into the water-world is full of peril. The first man to go down to a great depth was a gunnery instructor, in the British Navy, named Catto. At the end of a series of diving experiments made in 1906, he dived two hundred and ten feet, and was the first man who saw the sea at such a depth and lived to tell the tale. And to go down this short distance he had to be protected with a metal helmet and a metal breastplate, to keep his lungs free to breathe. Air was pumped down to him by six sailors, and it was forced through a tube that extended under the waves and entered the diver's helmet. A dress of thick rubber and leather kept out the heavy sea-water.

He had a terrible struggle to get back alive, for his life line became entangled at the bottom of the sea, and he had to grope around for twenty minutes before he got it clear. It took an hour and a half to draw him slowly back to the surface, for great care had to be taken to accustom him gradually to the atmosphere which we breathe. Lieutenant Damant then went down to the same depth, and this remained the record for diving for several years.

But in 1915, an American submarine met with an accident at Honolulu, while under water, and did not come again to the surface. Divers were sent out to find her, and one of them, named Frank Crilly, went down to where she lay two hundred and eighty-eight feet below the surface of the sea. He reached her in five minutes, but it took a hundred and five to draw him safely back again. Later, one of his fellow divers, a man named Laughlin, dived, but his life line became entangled at two hundred feet, and Crilly dived again and brought him up. The life line is the line by which a diver is let down into the sea and if it is entangled it is impossible to bring him back to safety. The submarine was raised to the surface, and the daring deeds of these divers represent the utmost that has been done in exploring on foot below the waves.

How little we should know about the land on which we live if we could not climb higher than ninety-six yards

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above the sea-level! An ordinary hill, barely three hundred feet high, would be a region of mystery to us. We should not know what went on in plains that now seem quite flat to us, though they lie often a considerable distance above the ordinary surface of the earth. The great mountains, sometimes rising nearly six miles into the sky, would be far beyond the range of our knowledge. We should be compelled to live in the lowest valleys and beneath the cliffs of the seashore, and no doubt we should be inclined to think that no form of life could exist in the places where we ourselves could not live.

DIVERS AT WORK ON A WRECKED SHIP FROM WHICH BARS OF GOLD ARE BEING SUCKED UP BY AIR

That is what the wisest men of science used to think about the underworld of water. We all know how heavy even a pail of water is. But let us try to imagine the weight of the Atlantic Ocean at a depth of two and a half miles! With two and a half miles of water above our heads we should be not merely flattened out like a pancake, but ground to powder. On every inch of our bodies there would be a pressure of two and a half tons, so that the force of the water weighing upon us would be enormous.

Now, we shall understand the impossibility of explorers going down to great depths if we remember that a column of water two and a half miles high would instantly produce a curious kind of crushing effect on the human body. Some time ago a man of science conducted some deep-sea experiments to ascertain the pressure of water at the depths of the ocean. He filled a glass tube with air, sealed it down, wrapped it in thick flannel, and put it in a thick copper tube. Tiny holes were made at the top and bottom of the tube, so that the water might enter; and then the tube was sent down into the sea to a depth of twelve thousand feet. When it was drawn up again, it was found that the copper wall of the tube had been flattened by a terrific force, and the glass was reduced to a fine powder which shone like snow. So rapid and violent had the pressure been that the water had not time to rush through the holes at both ends of the copper case. It had merely smashed the copper tube in, and ground the glass to powder by a sideways pressure. Thus it was discovered that the pressure on each inch of the body of an animal living at the bottom of the Atlantic is about twenty-five times greater than the power of a railway engine.

That was what these explorers found with the tubes they sent down in place of the bodies they could not take down, and naturally our men of science thought that no form of life could exist under such conditions as these. Nobody took any interest in what went on in the deep seas, and all these regions of our globe were regarded as dark and empty deserts of water in which nothing living could endure. It was supposed that fishes and crabs bred only in fairly shallow seas, and that when they swam about they kept to the upper layers of sea-water. It was apparently certain that an ordinary fish would be smashed to death and ground to powder if it swam down as deep as the glass tube in the copper case. Moreover, it was known that no sea plants grew at a greater depth than nine hundred feet below the waves. This is the limit at which the light of the sun stops in the water. Very often the light of the sun cannot pierce as far as this. But when the sea is very smooth, and the sun is very strong, and the sky is free from clouds, there is a faint glimmer six hundred yards below the waves. No light or heat from the sun travels, however, into the cold, dark ocean depths, and, owing to the absence of life-giving light, there is no seaweed on the floor of the deeper seas.

This was another argument in favour of the view that all the deeper parts of the great ocean were merely a cold, black, silent, empty region of desolation. For, as we know, all animal life is dependent on the foodstuffs stored up by green plants, and the power that plants possess of building up their foodstuffs depends on the presence of the green colouring matter in them, which needs sunlight in order to do its work.

Where there is no sunlight, said everybody, there could be no plant life; and where there is no plant life there could be no animal life; so beyond the depth of six hundred yards the ocean, with its enormous pressure of water, must be utterly uninhabitable.

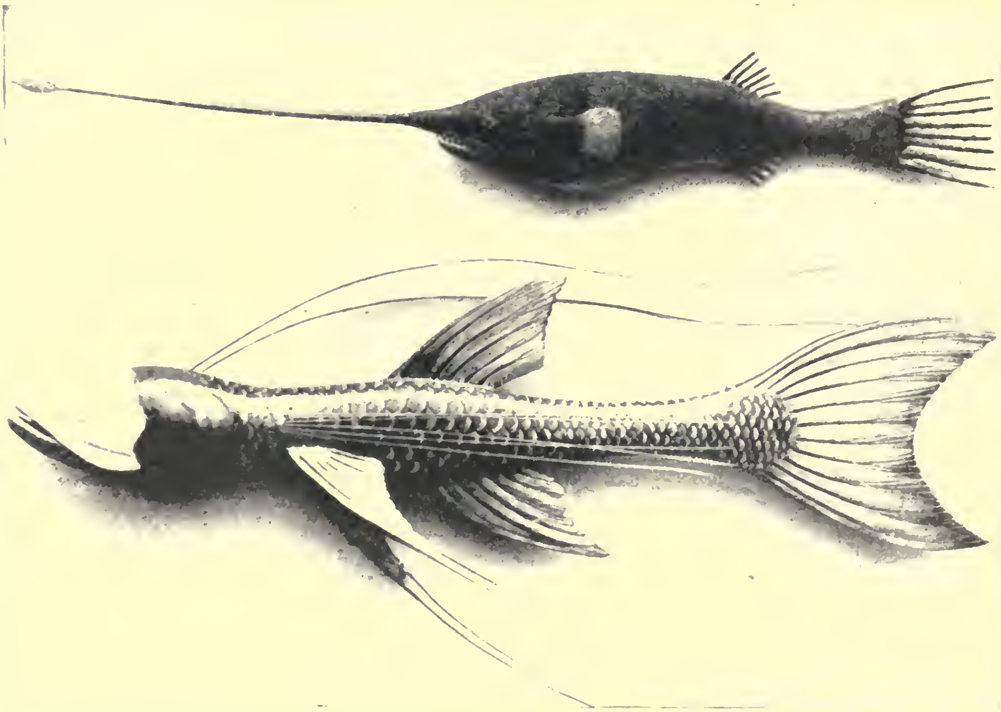
But a strange thing now came to the aid of the explorers of the ocean bed. In 1860 a telegraph cable in the Mediterranean broke at a depth of 7200 feet; and when the broken ends were raised up it was found that the cable was overgrown with sea animals in an astonishing variety of forms. At 7200 feet the floor of the sea is blacker than night, and freezing cold; yet it was seen that animals were able to live with tons of water crushing down on them, and with not a ray of sunlight to grow plants for them to feed on.

SOME OF THE CURIOUS INSTRUMENTS SENT DOWN INTO THE DEEP SEA TO BRING UP LIVING THINGS

Here, then, was a strange and mysterious thing, and men of science set out on warships from England and America to explore the wonderful kingdom of life so unexpectedly revealed.

Of course, no diver could descend to the ocean depths, for he would have been crushed to death by the awful pressure of water long before he reached the bottom. The only way of exploring the deep seas was to let down nets and iron hooks, and try to drag up some of the things living in the underworlds. The explorers also devised many instruments which would record the conditions of life in the abysses of the ocean—instruments for measuring the coldness of the deep sea-water, and wonderful bottles which opened when they touched the bottom and filled themselves full of the water there, then closed up tightly so that the water at higher levels could not enter. The nets were made in somewhat the same way. Opening as they touched the bottom, they closed up as soon as they were raised a foot or two from the floor of the sea, so that the animals taken in these nets could not have got in half-way between the ocean bed and the surface.

Many years were spent in exploring the new kingdom of life by such means as these, and in studying the marvellous creatures that were discovered, and within the last few years we have obtained a clear idea of the weird and marvellous country which lies quite close to us, yet is shut off from our eyes by the gates of death. Eternal darkness covers it; it is very cold, yet full of beautiful life. In some places the deep sea-floor is covered with a tall growth of branching stems, often eighteen feet long, of a pale lilac colour and a wild fairy radiance. It is not a plant, but a grouping of animals that grow together; it is called a polyp. This living wheatfield waves to and fro in the slow, chill, tidal current, glowing with soft, suffused light, and sparkling and flashing at the slightest touch. Now and then it breaks into avenues of vivid brightness, which indicate the path some fish has taken through this region of enchanted loveliness.



TWO OF THE STRANGE PHOSPHORESCENT FISHES THAT LIVE OVER A MILE DEEP IN THE SEA

Blind, red, crab-like forms crawl in and out of the strange undergrowth. But many of the creatures living in this sunless world of water not only have eyes, but shine with an inner radiance. There are living stars with a green, scintillating light; sea snakes with a white electric flame; lobsters pouring from their feelers a cloud of blue splendour; and creatures like little lighthouses sending out red, yellow, and green flashes. There are, indeed, myriads of little forms of life that carry small natural lamps about with them as they wander in the awful darkness of the deep sea.

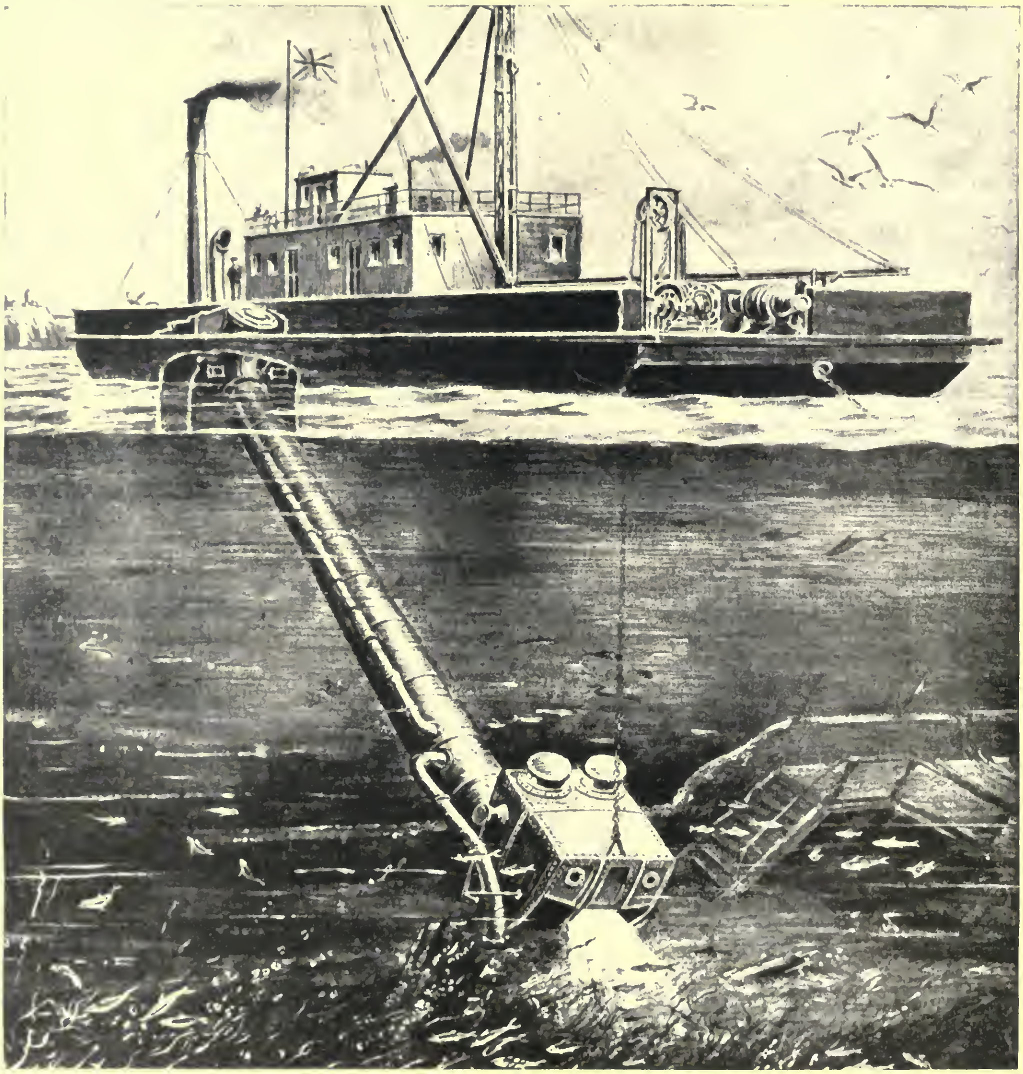
Only twelve hundred yards beneath the level of our shores lies this land of life, in which many living things emit a soft and lovely radiance. The fishes there are often quite different from those that our fishermen catch in shallower waters. There is, for instance, a kind of sea salmon which has a line of natural lamps running down the length of its body. Another dark black fish has two rows of red lights running from its head to its tail, and a hundred tiny lamps on its back and sides. This fish must be able to see very clearly its way through the strange and inky black world of the ocean abyss. Some fishes carry their lamps at the end of dangling fibres; in others the centres of light are placed behind the eyes or on the head and shoulders.

DIVERS RECOVERING TREASURE FROM A WRECK

One of the most beautiful of all these strange creatures of light is a kind of brittle-star, which was caught by iron hooks sent down into three thousand feet of water. It has been called the glory of the seas. A star-shaped creature with long arms, it has a brilliant green radiance, sparkling at the centre in a dazzling blaze, and then shooting first along one arm and then along another. Sometimes the whole outline of this marvellous fish is brilliantly lighted up with strange, wild, and beautiful green flames. There are also gigantic cuttlefishes, with suckers of enormous length, moving about like huge animated fireworks; and other weird and terrible shapes of flaming life haunt these black, icy waters of the underworld. It is possible that the floor of the ocean is as bright as the surface of a lake on a cloudless summer night, and that in places the abyss of the sea is like a city street with the lights ablaze.

WHAT THE WORLD IS LIKE AT THE BOTTOM OF THE SEA

The explorers declare that in some parts the floor of the sea is covered with millions of little creatures that shine like glow-lamps, and the discoveries that have been made in this direction are among the most interesting of all. When we make light by burning coal, or gas, or chemicals, or by passing a current of electricity through the filaments of a lamp, we waste nearly all the energy in heat; only a very little of it is transformed into light. But the phosphorescent light of deep-sea creatures—like the light of a glow-worm is made without any waste whatever in heat. It is pure light; and a huge fortune awaits the man who can discover the way to make light in this way. These creatures of the sea have a secret which would be worth millions to us who live on land. Even some sharks are able to light up their path through the deep sea with a white and heatless radiance. Certain glands in their skin give out a sticky substance, and it is this substance that makes them a shape of living fire. It is doubtful, however, if the shark ever penetrates to the deep ocean beds, and it is in the deep-sea fishes that the organ of light is best developed. It often forms a sort of eye, or a series of eyes, that shine like a row of bull's-eye lanterns.



A NEW WAY OF EXPLORING THE OCEAN BED AND RECOVERING LOST TREASURE FROM WRECKS
The explorers go down a tube, five feet wide, to a kind of diving bell, fitted with a powerful searchlight.

The real eyes of the deep-sea fishes are very curious. Those down in the great abysses have sometimes uncommonly big eyes and sometimes astonishingly small eyes. Very few have lost their sight, as fishes do that live in underground lakes and streams and pass their life in total darkness. One crab-like creature crawling about the sunless depths of the ocean seems to have had a hard struggle to see what was going on around him, for he has now an enormous pair of eyes, each provided with four thousand facets. He is a terrifying kind of animal, but very intelligent. The crabs and lobsters of the deep seas have much more intelligence than the fishes.

Perhaps we have noticed that when a glow-worm is alarmed she puts out the green light at her tail. In this way she often manages to escape from her enemies. It is very likely that many of the curious light-bearing creatures of the ocean deeps have a similar power of turning out their lamps when a foe flashes upon them from a distance. They are then left in absolute darkness, yet it is necessary for them to move out of the way, and know where they are going to. So we find that some of the fishes of the abyss have developed very sensitive organs of touch. Their fins have grown into long feelers, and by means of these they are able to tell from the movement of the water what is happening around them. The crabs and lobsters living miles below the foam and wash of the waves also possess remarkably long feelers. Some of them have legs like stilts, which enable them to walk about the thick, grey ooze of the ocean bed. Another weird feature of the crabs and crayfish of the deep seas is their manner of protecting themselves against attack by means of long spines that grow out of their shells and make them look like gigantic hedgehogs.

THE TINY SPECKS OF LIFE IN THE SEA KNOWN AS DIATOMS

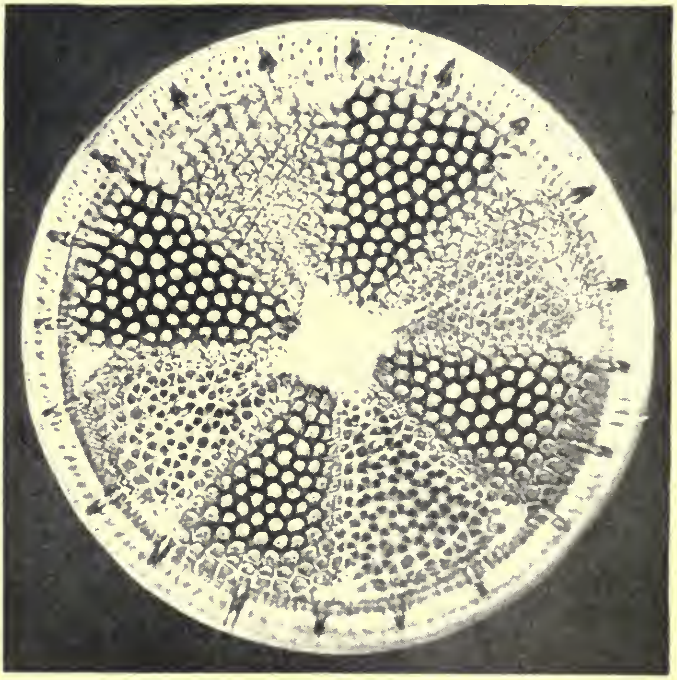
Little is yet known about the means by which the creatures of the ocean abysses are able to withstand the enormous pressure of the water in which they live and move. The explorers who have found them out have not yet solved the mysteries of their origin and life. All that is clearly known is that none of the fish of the shallow seas—herrings, salmon, codfish, and so on—can withstand a great weight of water, for when they are put into an experimental tank, and when the water in this tank is compressed by a steam-engine, they fall into a swoon, and do not recover if the pressure is maintained for any length of time. All the fish of the deep sea, however, have very curious bones. They are thin and soft, and some are sinewy fibres rather than bones. No doubt this makes their bodies more elastic than those of ordinary creatures, and perhaps it is this elasticity that helps them to live under a weight of hundreds of tons that would crush to powder most other creatures.

But, though the inhabitants of the ocean abysses are able to live under an enormous load of water, they are liable to extraordinary accidents. If, in searching for food, they rise a considerable distance above the floor of the sea, the gases of their swimming bladder expand, and they become lighter. Up to a certain point the muscles of their bodies can fight against this strange tendency to go floating upwards; and the deep-sea fish that has not completely lost control of itself can win its way back to its home in the dark, cold, heavy water. But if it travels too far towards the world of sunlight, its muscles are not strong enough to drive the body down. The fish continues to swell, and is gradually killed in its long and strange voyage to the surface of the sea. Thus the deep-sea fishes are exposed to a danger that comes to no other animal in the world—the danger of tumbling upwards! That such accidents do occasionally occur is shown by the fact that some unknown kinds of fish, now known to be deep-sea forms, were found floating dead on the level of the ocean long before men dreamed that life could exist at such a depth.

The great problem which has perplexed the explorers of the deep seas for many years is the question of how life is maintained so far below the waters. What do the creatures of the abyss feed upon? It is clear that they cannot keep up life merely by eating each other, for this would mean that the biggest would eventually swallow all the rest, and then die of starvation because there was nothing more to eat. All animal life must have plant life to feed on. This is as true of the wild, strange animals of the deep as of the cattle of our pastures. But we have seen that no ordinary plants can grow in the sunless underworld of water. How, then, is animal life maintained there? A few years ago no man was able to answer this question properly, and it was not until great progress had been made in the study of those invisible forms of life known as microbes that the secret of the ocean abyss was fully revealed.

When a sailor is voyaging across the sea, he may think he is sailing through an almost barren waste of waters. But he is actually floating over the richest territories of the earth, and beneath his ship is a wealth of life more abundant than the most luxuriant forest. Below his feet may be miles of water, and every cupful teems with life! Nothing living may be visible, yet every yard of the upper sea contains 600 million living things. The greater number of these invisible shapes of life are microbes, microbe being a Greek word that means *small life*. There are many learned names for these microbes, and it is often difficult to distinguish one kind from another. Some microbes are little animals, and others are little plants, but many are half-way between plant and animal. And in some strange way a great number of the real plant microbes can move about as if they were actually animals. They possess tiny hair-like, quivering things, and by means of these they row about the seas. It would be amazing to see a cabbage or a rose-bush get up and walk about a garden, but it is still more amazing to find that the very lowest form of plant life, a thing much simpler than a tiny seed, can travel through the seas by means of little oars. Some of these little moving plants are so small that they escape through the finest net, and some cannot be seen at all under the most powerful microscope.

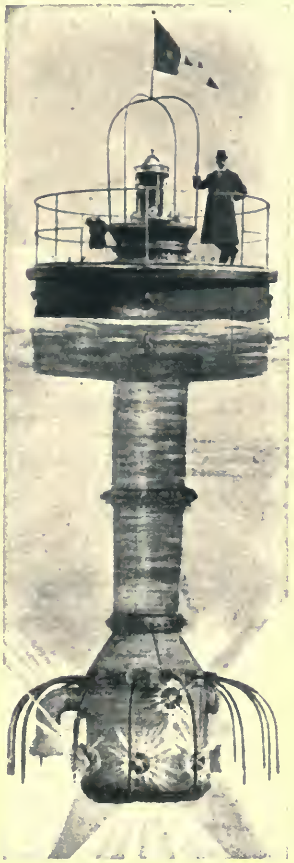
Though these living plants are rovers, ever moving through the sea, an amazing thing about them is their power of building houses for themselves. They build around themselves shells of the most beautiful pattern, shells so small that if you look at a glass of sea-water containing many of them the water seems quite empty and clear. These minute plant-cells, which build shells for themselves out of fine minerals floating in the sea-water, are known as diatoms. They are really a kind of seaweed. One of these diatoms, living in the mud, has a shell fashioned like a tiny double-stemmed boat, and can travel about from place to place by means of some power quite unknown. Hundreds of men of science have spent years in studying these tiny seaweeds, which seem to be moving shell animals, but are really only plants; but no explorers of the seas, and no student of ocean life, has found out by what power they can move.



ONE DIATOM. MAGNIFIED OVER A QUARTER OF A MILLION TIMES

Now, it is these diatoms which make the sea a pasture. They are to the fishes and animals of the ocean what the grass is to the cattle in the fields. They live in the surface waters, where they can use the sunlight in building up their bodies. They are like little chemical factories, employing the heat and light of the sun in making food from the minerals dissolved in sea-water. They multiply at an astonishingly rapid rate, and when they die their bodies fall into the depths of the ocean and provide food for the animals there. There is, in fact, a continual rain of diatoms falling from the sunny surface waters on to the dark, cold bed of the sea.

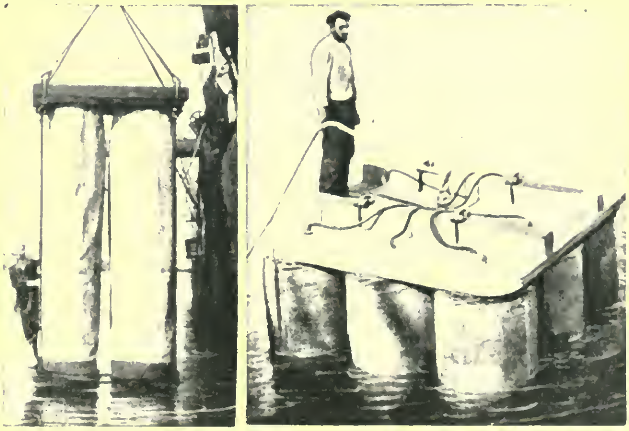
This rain of food seems to be greatest in the early spring and in the autumn, and it is very likely that in these two harvest times the creatures of the gloomy depths rejoice in their way and find their mates and marry.



A WATER TELESCOPE FOR SEARCHING THE DEEP SEA

Besides the diatoms, there are many other microbes in the sea. Some of them are tiny animals with shells that fall through the ocean and form a thick grey dust at a depth of three miles below the waves. There are also many microbes which have no shell, and some of these are able to shine in the dark, as the deep-sea fishes do. To the man of science the strangest and most wonderful of all these microbes are those sometimes brought up with the ooze of the abysses, for these marvellous forms of plant life have no need whatever of sunlight, and grow best in the freezing darkness of the underworld. They feed entirely upon the icy water itself, and need no air or heat or light.

They manifest the triumph of the spirit of life over all the terrors of death. Above them is a swaying mass of water with the crushing weight of a mountain. Around them are eternal darkness, and a freezing tide slowly flowing from the ice-bound seas of the Poles. The sun is miles away; and miles away also is every other form of plant life. Yet in the cold, black sea-water the miraculous microbe feeds itself and produces food for the animals of the abyss. In some cases it also produces soft and lovely light, for luminous microbes have been found a thousand yards below the surface of the sea.



AN AIR-BAG LIFT FOR RAISING SUNKEN TREASURE

Such are some of the creatures discovered by the explorers of the sea. But all the wonders of the deep are not yet known. Man, with his rough instruments, has only explored the fringe of the mysterious kingdoms of the deep ocean. It is very likely that strange and weird monsters, too large to be caught by the explorers' nets, live in the uttermost abysses of the water-world. Perhaps one of them will get out of his depth some day and tumble upwards in the path of a ship. We can hardly believe that we shall ever see one of these monsters alive. For, like the other deep-sea creatures, it would kill itself if it attempted to leave its home. Being made to withstand the pressure of water miles below the sea, it could not rise to the surface and live.

Lord Tennyson wrote a poem in which, long before we had our present knowledge, he imagined what the bottom of the sea is like, and his fancies are proving strangely true. In his poem he included the legend that a terrible dragon the Kraken lives in the sea-depths, but will never be seen till the end of the world when the seas are dried up.

Will man ever stand alive in an ocean abyss as far below the sea-level as Mount Everest is above it? We can almost certainly say "No," for it would need a submarine with a window strong enough to resist the weight of a mountain. Man will go on inventing, the explorers will go on discovering, and we shall know more and more of the wonders of the regions of the depths of the sea. But never, perhaps, will man fling wide open these gates of death and darkness which hide from our eyes the wonders of life in the abyss.

All this wonderful knowledge of ocean life belongs to the science of oceanography, which means the science of the ocean, just as geography means the science of the surface of the earth. Oceanography is a department of geography. It is only within the last forty years that much has been known about the ocean depths, for it is only since that time that machinery suitable for deep-sea dredging has been invented. Now by means of beam-trawls, dredges, tangle-bars, and many such devices, naturalists or those men who explore the ocean bed, can obtain living objects or their bony remains at the depth of even three to four thousand fathoms, or more than four miles.

A beam-trawl is a buoyed line, often of great length, to which short lines with baited hooks are attached at suitable intervals. The mouth is kept open by a beam. You may have seen a dredge scoop up earth and rocks in a river where the channel is being widened or deepened, or where an excavation is being made for the foundation of a building. In a similar manner the deep-sea dredge scrapes up the bottom ooze from the ocean-bed. This kind of dredge is controlled by machinery on board the ship to which it is attached. Often in dredging, a tangle-bar is used to sweep the floor of the ocean for delicate forms of marine life, too small or too fragile to be obtained in ordinary dredging. The bar, which is supported on runners, drags after it many masses of hemp, like our floor-mops, arranged one after the other, and these entangle the more minute and delicate forms of marine life without injuring them. Many different kinds of nets, specially made for this purpose, are also used.

As early as 1839, Sir James Clark Ross, during a cruise in the Antarctic Ocean, successfully sounded the greater depths of the ocean with ordinary sounding lines and heavy weights from small boats. These sounding lines, which were a mile long, were made of stout hemp. Instead of these, Captain Matthew Fontaine Maury, U. S. N., introduced a ball of strong twine, attached to a cannon shot, which ran it out rapidly. When the bottom was reached, the twine was cut and the depth calculated from the length of string left in the ball on board. Maury, however, realised that the surest proof of having reached the bottom was to bring up a sample of the deposit. In 1854, Lieutenant J. M. Brooke, U. S. N., invented the principle of using a heavy weight on the sounding-tube in such a way that when it struck the bottom, the weight was released and left behind, while the light brass tube containing a sample of the deposit was easily hauled up. From that time on deep soundings were recorded more frequently and more accurately and better samples of the deposits were obtained.

The "Challenger" expedition was sent out in 1872 by the British government, under the direction of Sir Wyville Thomson. During a voyage of four years the expedition sailed around the world and made continuous observations of the plant and animal life at all depths throughout the great oceans. The results of these observations, which were written by Sir John Murray, one of the chief naturalists of the expedition, laid down the broad and general foundations of the modern science of oceanography. Sir John Murray later directed several other expeditions for marine exploration and in 1910 took a leading part in the expedition on the "Michael Sars" for the investigation of the North Atlantic Ocean. For his work in this field he has received many honours from the chief scientific societies of the world.

About the same time as the "Challenger" voyage, a German expedition in S. M. S. "Gazelle" made very extensive observations in the South Atlantic, Indian, and South Pacific oceans, and the U. S. S. "Tuscarora" made a cruise in the North Pacific, sounding out lines for a projected cable.

During the past thirty years, nearly every civilised nation has sent forth expeditions for deep-sea exploration, and during the past fifteen years an International Commission has been engaged in directing such exploration in the North and Norwegian Seas.

Although our knowledge of conditions in the great ocean-basins is due to the combined work and observations of a great many men of different nationalities, we owe more to the work and inspiration of Alexander Agassiz than to any other man. He directed three expeditions in the Atlantic Ocean in U. S. S. "Blake," and then in the Pacific in U. S. S. "Albatross."

Alexander Agassiz, the son of the famous naturalist, Louis Agassiz, early in life began the study of oceanography. When the "Challenger" expedition reached Halifax in 1873, Agassiz visited the ship and was very enthusiastic over the specimens they had captured. From his previous study and observation, he was able to teach the naturalists of that expedition many interesting things about some of the specimens that had puzzled them. Since that time, scientists all over the world have considered him an authority on certain forms of animal ocean life.

His explorations in the West Indies have taught us more about that submarine area and the animals inhabiting it than any other area of equal extent in the world. In the Pacific expedition he verified and added to the knowledge already obtained by the explorations of the "Challenger" expedition.

During the last thirty years of his life Agassiz became greatly interested in all coral reef formations and organised many extended expeditions almost entirely at his own expense, for the purpose of studying such formations. In this work he visited, explored and described with much detail every important coral reef region in the world, in the Atlantic, Pacific and Indian Oceans. He travelled more extensively than any other man of his time, all with the one purpose — to see with his own eyes the varied forms which these gigantic and beautiful natural structures assume under different conditions. When we take into account also the vast amount of time spent in the laboratory in study and in making reports of his observations, we are more than ever impressed with his great desire to add to the sum of human knowledge by his own work and the impulse he could give to others imbued with similar spirit and desire.

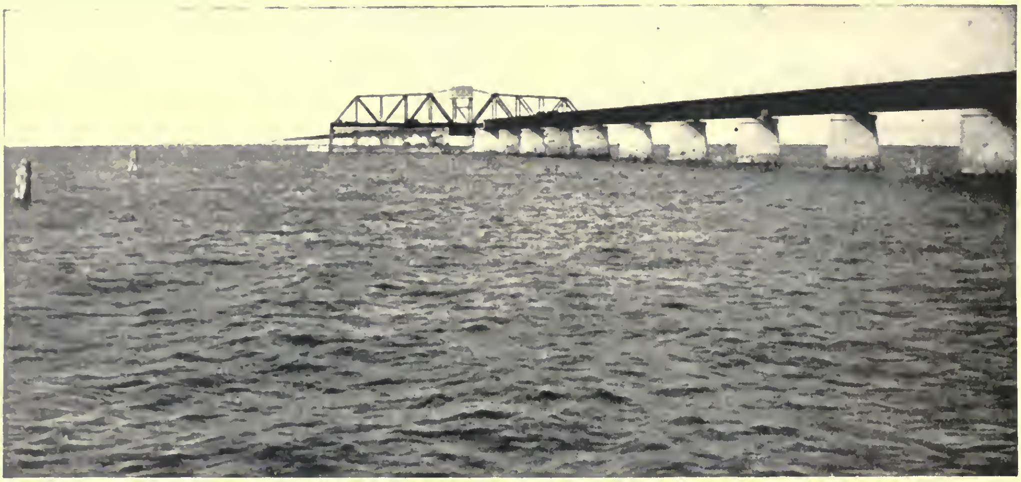
In the United States ocean exploration has been carried on chiefly by the Bureau of Fisheries, which was established in 1871. This bureau is especially concerned with the problems that have to do with the production and protection of the fishes used for food. Besides much valuable work which has resulted in the increased supply of shad, salmon, whitefish, cod, lobster and other fish food, the Bureau has made a thorough study of oysters, sponges, and seals.

For the survey of offshore fishing-grounds and the general exploration of the seas, the Bureau has had, since 1882, the steamer "Albatross," which was especially built for this purpose. It is said that the "Albatross" has contributed more to the knowledge of the life of the sea than any other vessel. Previous to the cruises in the Pacific, under the direction of Agassiz, it was engaged for several years in the investigation of the fishing-grounds of the Atlantic Coast of North America. Since 1907 the vessel has been in the waters surrounding the Philippine Islands, where a special study of marine life is being made. The deepest sounding made by the "Albatross" is 4,813 fathoms, or about five and a half miles. The greatest depth at which the vessel found life was 4,173 fathoms, almost 4¾ miles. The greatest ocean depth known is 5,269 fathoms, which is very nearly six miles.

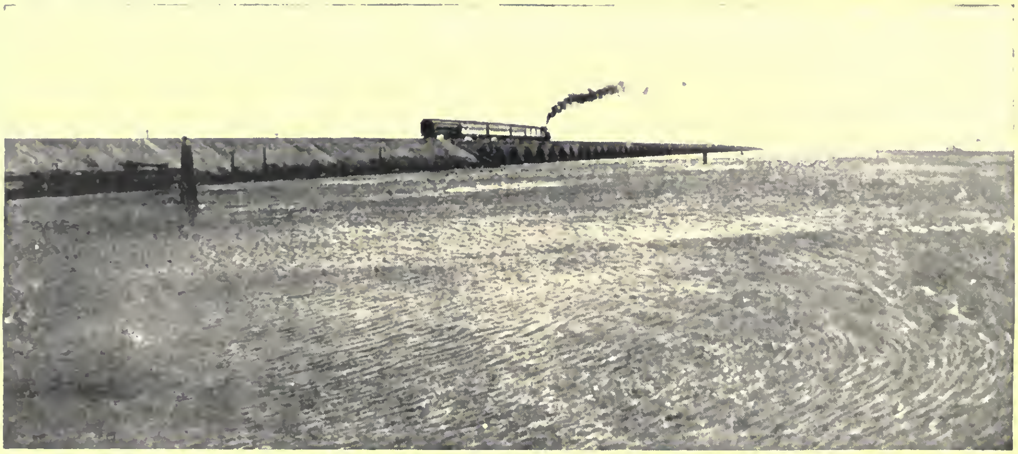
Work similar to that done by the "Albatross" in the Pacific is conducted by the steamer "Fish Hawk" on the Atlantic coast. During the summer of 1912, a special study of the waters of the Gulf of Maine was made in the U. S. Fisheries Schooner "Grampus" under the direction of Henry B. Bigelow.

For the study of the specimens obtained two seaside laboratories have been established, one at Wood's Hole, Massachusetts, and the other on a small island near Beaufort, North Carolina. These are controlled by the Federal government, but there are many other laboratories, as well as vessels, maintained by different states, that are doing most valuable work in advancing the science of oceanography.

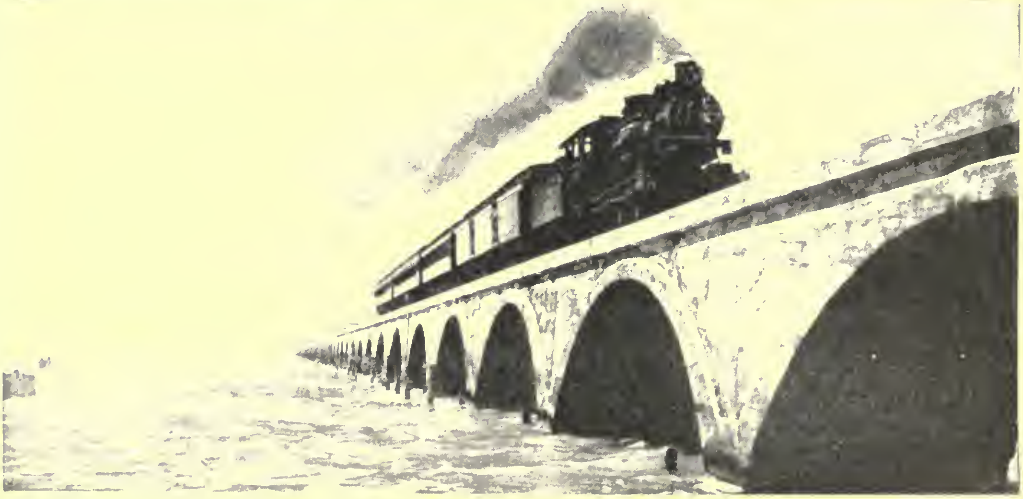
BRIDGES OF THE GREAT OVERSEAS RAILWAY



THE DRAWBRIDGE TO ALLOW THE PASSAGE OF SHIPS THROUGH THE GREAT KNIGHTS' KEY VIADUCT



THE LONG KEY VIADUCT, WHICH CROSSES TWO AND A QUARTER MILES OF SEA



A NEAR VIEW OF A TRAIN PASSING OVER THE LONG KEY VIADUCT

STEPPING-STONES OVER THE SEA

. HOW UNSEEN HANDS THROUGHOUT THE AGES LAID THE FOUNDATIONS OF THE MOST REMARKABLE RAILWAY IN THE WORLD

THE CORAL BUILDERS OF THE OCEAN BED

AMONG the smallest of living creatures man finds some of his most useful allies. Tiny animals and insects work, unconsciously, for his benefit. But perhaps there are not many more astonishing stories in Nature than the story of the little coral animals of the coast of Florida, which have laid the foundations of a remarkable human achievement. Tiny soft-bodied animals, they extract mineral substances from the sea-water, and form living skeleton dwellings. Millions of coral polyps are born, labour, and die, and their work is carried on by still further millions, till huge coral formations rise from the beds of shallow seas. The work of these coral polyps has made possible a wonderful American railway which has lately been opened to carry trains out to sea.

The purpose of this railway is simply that a busy man, taking his seat in a train in New York, only has to leave that train once before he reaches Havana, which is the capital of Cuba, almost two thousand miles away. To understand what that means we ought to peep for a moment at the map. We see that not only must the American at present make a long journey by land, but cross the open sea. Did any of us ever go to sea in a train? Well, we can all do so by travelling on this new railway, which is called the Florida East Coast Railway Extension, and deserves to be known as one of the greatest wonders of the modern world.

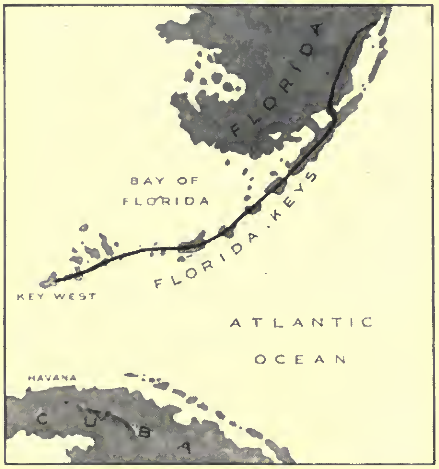
From the point at which the railway goes out to sea to the point at which the line stops is a distance of 156 miles. Then we have the open Florida Strait, across which it would be unsafe to build a railway. Here there is a large ferry-boat for goods trains, but the passengers alight from the train and get on to a boat which takes them to Havana, a further distance of ninety miles.

All this sounds "frightfully fascinating," as Wendy says, but what have the tiny polyps to do with it? They built the foundations of the railway ages and ages ago. The busy little coral animals, building and building and building, raised an enormous number of islands of coral from below the water to the surface of the waves, and those islands serve now to carry the lines for the new railway. Some of the islands are so big that they support quite a good length of track; but their use generally lies in the fact that they are built close together, so the engineers have been able to build great embankments and viaducts to join them together, enabling the train to run along from island to island, as comfortably as if it were on the line from New York to Boston. But for these wonderful little creatures there could have been no railway from Miami out over the waters to Key West.

Key West is itself on one of these islands, and is of great importance to the United States, for it is a naval station at which ocean-going vessels call, and it is the nearest naval base to the new Panama Canal. From Key West to the coast of Florida we have a chain of stepping-stones for the railway which the coral animals have built. We have all seen the stepping-stones which are set in the course of shallow streams to enable us to cross the water without getting wet. The coral islands serve the same purpose for the railway: but, of course, there they are much more important, and instead of one or two pairs of hands being required to do the work necessary for making the crossing, this railway has employed 3000 men to take advantage of its stepping-stones, and a sum of more than $20,000,000 has been spent to complete the scheme.

As the railway is the most wonderful of its kind in the world, we can profitably spend a few minutes in learning how the work has been done; for it is as good as a fairy story, except for the fact that there are some terrible tragedies to tell in connection with it.

Before we build a railway we have to get surveyors carefully to plan the line, and the surveyors for this line had a most difficult task, for their work had to be done at sea, and often they had to erect tall towers on which to place the instruments used for the work. Some of the men engaged in the work got lost in what are called the Everglades. This is an area in which there are thousands of little islands, infested with swarms of fierce man-eating alligators. In this tract, and among the many coral islands, or keys, as they are called, farther out from the coast, men lost themselves for days at a time, and had to be sought by relief expeditions when on the brink of starvation and madness. But the surveying was finished, as all things are finished when determined men undertake the work, and the building began.



THE CORAL ISLANDS, BUILT BY ANIMALS, UPON WHICH THE FLORIDA RAILWAY RUNS

In the track of the railway lie forty-seven islands. Each of these is made to carry a length of the railway. But there are varying distances between the islands. In some cases the space is only a few hundred yards, in others it is as much as six miles. Where the distance was short it was easy to carry the line.

All that the engineers had to do was to imitate the coral animals, and build up from the bottom of the water with concrete and stone and steel. In this way an embankment was built joining island to island. The embankments had to be raised to a height of thirty feet above high water, and the bed on which the track crosses the viaducts was laid at the same level. Careful examination has shown that the highest waves in these seas do not reach more than twenty-five feet; therefore the track is five feet above the top of the highest wave.

We have used the word "viaduct," a word meaning, as we all know, a bridge which carries us a distance over a chasm. These viaducts are used for this railway where the distance between the islands is too great for an embankment to serve. As we have seen, there is in some cases six miles of sea between one island and the next. Here, in some cases, the engineers built out embankments from each island; then, when they could go no farther, they joined the ends of the two embankments together with a great viaduct. To build these viaducts they had to sink dummy piers, arched in shape, and force down into the bed of the sea watertight cofferdams, from which the water could be pumped out. When the water was drawn out, there was a space inside the cofferdams into which the men could fix great rods of steel. Then they poured cement into the cofferdams and allowed it twenty-eight days in which to set. At the end of that time they drew away the timber framework, and floated it off in barges, and there they had foundations on which to build up the bed of the railway.

Although the distance between some of the islands is more than six miles, the engineers found that by carefully building out their embankments they needed in some cases to bridge distances of only one or two miles. Even this is a big jump out across the sea, of course. But one of the viaducts, that at Knight's Key, is nearly seven miles long. It is built upon 185 great concrete pillars and arches, and is one of the greatest triumphs of this wonderful railway. But the whole distance of the railway over the sea, including islands, embankments, and viaducts, is 128 miles. The material used in it is enormous. There are 286,000 barrels of cement; the crushed rock used would make a road 100 miles long, and one yard broad, and one yard high; the sand used would give us a little beach 60 miles long, one yard high, and one yard broad. The steel rods used weighed 5700 tons, and the amount of wood employed would startle a timber merchant.

In this way the work was carried out. On the islands themselves the line was laid at the right level as upon any ordinary railway; for the small gaps between the islands embankments were sunk in the sea; for the greater distances embankments and viaducts were called into existence. When the line had been carried out a distance of 109 miles from Miami, the engineers built a railway station, and called it Marathon, and they built a dock at the same place. Here

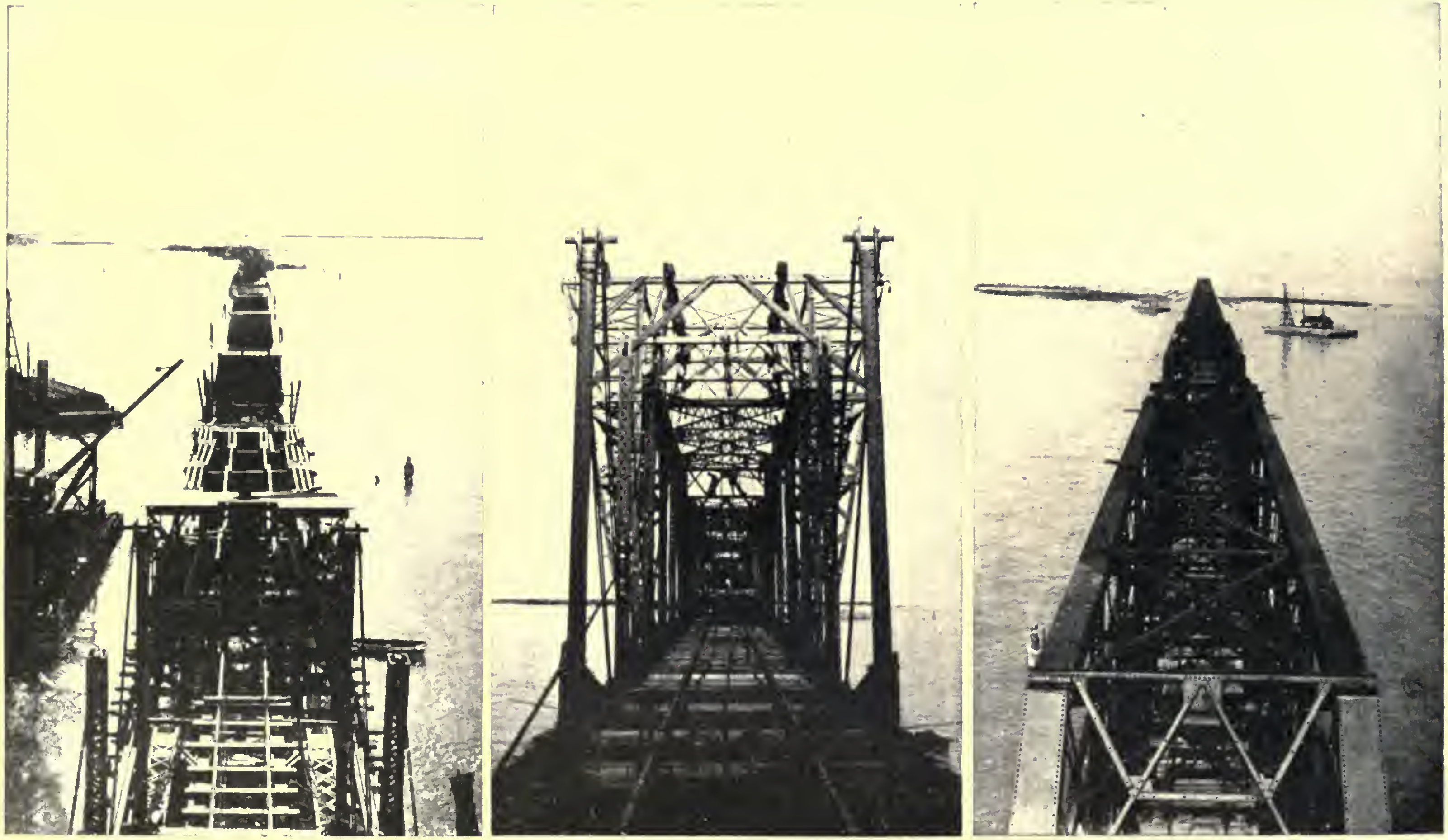
CARRYING THE RAILWAY OVER THE ISLANDS

A TRACK FOR THE RAILWAY CUT THROUGH A THICK FOREST OF PALM-TREES

JOINING UP TWO ISLANDS BY A GREAT EARTH EMBANKMENT

LOOKING ALONG THE TOP OF AN EMBANKMENT BETWEEN TWO DISTANT ISLANDS

THE WONDERFUL ROAD OF IRON THAT REACHES OUT FOR A MILE ACROSS THE SEA



THESE THREE PICTURES SHOW THE BUILDING OF THE GREAT BAHIA HONDA VIADUCT, WHICH IS MORE THAN A MILE LONG. ON THE LEFT WE ARE LOOKING SOUTH, ON THE RIGHT NORTH, AND THE MIDDLE PICTURE SHOWS THE GIGANTIC TRAVELLING CRANE WHICH PLACED THE GIRDERS IN POSITION a new city has been brought into existence, with the sea all round it, with a railway station for its front entrance and a dock for its back premises. Ships bring things to one door and trains carry them away from the other, and trains run all the way from New York to Key West and Havana, carrying merchandise only, and taking back from Havana the loads of fruits and other foods which grow abundantly in the glorious climate and teeming soil of the island of Cuba.

To complete the journey from Key West to the capital of Cuba, the passengers must go on board ship, we remember. The ships draw up where the line ends. There are railway tracks on board the ship, and on to these the freight trains run. They are securely fixed, and away they go. The trains carry the merchandise; the ships carry the trains. Many people hope that some day similar steamers will carry British trains across from England to France and will also take passengers, and bring back French trains from France to England by the like means.

The Russians have for several years been in the habit of carrying railway trains on ships across the great Siberian Lake Baikal. The ships which carry these trains of the Trans-Siberian Railway across that large inland sea were built by an English Company.

A TRAIN CROSSING THE MILE-LONG BRIDGE ABOVE THE SEA

There has seldom been more romance in the making of a railway than in the making of this one which we are now considering. The work had to be done very largely from ships and boats. All sorts of vessels were employed. There were steam tugs, large steamers, launches driven by gasolene, boats fitted up with cranes and cement-mixers; there was a great floating pile-driver; there was a floating machine shop; there were scores and scores of barges and other craft for carrying material; and there were, above all, the houseboats in which the workers lived. Of these latter vessels there were fourteen, each one being the home of 144 men. The white men lived on these houseboats; the negroes lived in little wooden houses built on the islands. These islands, which the coral polyps built, are covered with glorious palms and other vegetation planted by nature. In one of the islands the engineers discovered a man who had lived there, like a Robinson Crusoe, all alone for thirty years, feeding on fruit and fish and birds. The food of the men was taken to them by the railway company, so that they should lack no comfort; and a hospital was built for them at Miami. The one thing that the men could not have was intoxicating drink. Most of them were very glad of this, but some of the black sheep tried to get it, and boats carrying liquor would steal out to the works; but a special guard was kept for these, and when the boats were caught their crews were locked up, while the boats themselves were sunk. Thus it was a happy and healthy colony carrying out the work in a scene of wonderful natural beauty and splendour, but one in which there were risks from the alligators, and risks, too, from the weather.

Few men were able to work from start to finish of the railway, the work being so hard and, all told, 20,000 workmen laboured from time to time in keeping the army of toilers up to 3000. Sometimes gaps were caused by tragedies for which the work itself was not responsible.

There was a terrible disaster when the arches of the Long Key Viaduct were being built. Ninety of the arches had been completed when a tornado swept down upon the scene. The finished arches stood the storm well, but the framework of those which were in course of building was overthrown and swept out to sea. Vessels were torn from their anchorages and carried off to sea, and a great deal of property was lost. The camps of the negroes on the islands were blown down, and the men were in much danger.

THE GIGANTIC KNIGHTS' KEY BRIDGE, SEVEN MILES LONG

Worse still was the fate of many of the men on the houseboats. One of these houseboats was torn from her anchorage and driven by the raging wind out to sea, and dashed to pieces on a reef. Before this happened, however, heroic scenes on board were witnessed.

Many men were so horrified by panic that they collected together down in the hold and waited for destruction. One of the engineers gave his life for these poor men. He went below and begged them to go up on deck, so that they might be ready to swim for life when the vessel should strike. While he was persuading them to come up and save themselves the vessel struck, and he was killed by a falling beam as the upper part of the vessel was dashed in. There were 145 men on board, and terrible scenes followed. Some of the men, however, were as cool as if nothing were happening.

After the houseboat struck, no fewer than 87 men were rescued at once from the sea. An Italian steamer went to their rescue and saved 44 of them. She was not satisfied with this, but had her boats out all night seeking others in the storm-tossed sea. Many a time voices were heard crying out in the darkness, the voices of men whom the brave boatmen were unable to find and save.

The British ship Alton rescued 26 of the men, and other vessels passing on their way picked up more. For the next few weeks men from the railway wreck were reported alive from all parts of the world—from Galveston, New York, Buenos Ayres, from London, and Liverpool. Ships passing on their way had rescued them and continued their voyages, carrying the men with them.

Such are some of the adventures which the men have experienced who have helped to make this wonderful railway out over the broad sea. It is a sad tale, but those who came through the tragedy are proud to tell of their adventures, and to declare that they would go through it again for the glory of helping to build this the most remarkable railway that the world has yet seen. All honour to them for the work they have done, but we will not forget the thanks due to the little builders of the coral islands. They cannot speak for themselves to claim their share of glory.

This sea railway was finished a few years ago, and trains run on it, with the waves of the Atlantic sending up spray on the one side, while the Gulf of Mexico washes the foundation of the railway on the other side. The undertaking has been carried out at a cost of $150,000 per mile, making the Florida East Coast Railway Extension one of the costliest in the world, except mountain and city railways.

ALUMINUM

ONE OF THE STRONGEST AND LIGHTEST OF METALS

By permission of The Aluminum Cooking Utensil Co.

The utensils in this camper's outfit are made of aluminum because that metal is lighter and more durable than any other used for this purpose.

IN 1856, Napoleon III presented his son, the Prince Imperial of France, with an aluminum rattle. It cost about $1,000; but to-day were it not for its historic value, it could be bought for twenty-five cents. At that time aluminum sold for $100 a pound. Of recent years it has brought from eighteen to thirty cents a pound.

This difference in price in Napoleon's time and to-day was not due to the scarcity of the metal, for it is found everywhere. Although iron is the most common of our metals, aluminum is the most abundant, for it forms eight per cent of the earth's crust. It is the basic metal of all clays just as sodium is the basic metal of common salt. It enters into the composition of all rocks. The ruby and the sapphire are practically nothing more than aluminum and oxygen. The turquoise, the topaz, the garnet, and the emerald also contain it.

DISCOVERY OF ALUMINUM

Although so very abundant, the existence of aluminum was not suspected until about a century ago. In 1808 Sir Humphrey Davy suggested that clay and many rocks of similar formation depend on some metal as the base. Twenty years later, Frederick Woehler, a German chemist, proved this to be correct. In 1845 he succeeded in isolating aluminum in a globular form. At the Paris Exposition in 1878, it was sold in sheet, wire, foil and ingot, at sixteen dollars a pound.

DISCOVERY OF THE PROCESS OF REDUCTION

But all the methods used for isolating the metal from the ores in which it is found were very expensive. As scientists began to realise the properties of the metal they bent their energies to discover a cheaper method.

Little progress was made, however, until the wonderful development of the dynamo, which, for the first time in the history of the world, made electricity cheap. Experiments then turned to electrolysis rather than chemical action and the discovery of the process used today in America was made by a young American student of the metal.

CHARLES MARTIN HALL, THE FOUNDER OF THE ALUMINUM INDUSTRY IN AMERICA

While a student at Oberlin College, Charles Martin Hall made many successful experiments with the metal. In February, 1886, eight months after his graduation, he discovered a method of extracting the metal from the ores in which it is found, by electrical means.

Though the college laboratory in which he worked was not equipped like those of our modern universities and the eager young investigator was obliged to make his own apparatus, he obtained results which no other experimenter, not even those provided with the most perfect equipment, had up to that time obtained.

By his later discoveries and inventions he reduced the price of aluminum from

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twelve dollars a pound in 1886 to eighteen cents a pound in 1914.

A few months later Dr. Paul Heroult, also a young man just out of college, working independently in France, discovered a similar process. Neither then knew of the other's work.

Today the Hall process is that used in America while the one prevailing in Europe bears Heroult's name.

Manufacture by these processes has so reduced the cost of production that the precious metal of half-a-century ago has become one of the cheapest of all the metals extensively used in the arts and industries of the world.

BAUXITE, THE ORE

Bauxite, which is the best ore, is a reddish clay found on the surface of the earth, in the same manner as brick clay. It gets its name from Les Baux, a city in France, where it was first found in abundance. Beds thirty-six feet thick and ten miles long, are still found there. Besides other large deposits in Southern France, it is found in Ireland and Austria. In America there are large deposits in Alabama, Georgia and Arkansas.

The ore is loosened from its bed by blasting, and is carried from the mine to the nearest siding in small narrow-gauge cars. After the ore is crushed, it is treated chemically and reduced to alumina, or oxide of aluminum, which is a white powder.

REDUCTION OF ALUMINUM

This powder is taken to a reduction plant where the metal is extracted.

The alumina is then put into an electric furnace with cryolite. This rectangular furnace, or pot, is lined with graphite, and long vertical rods are attached to carbons, which go down into the bottom of the pot. An electric current passes through the furnace. This transforms the alumina and cryolite into a molten mass and separates the aluminum from it. The aluminum sinks to the bottom because it is heavier than the slag, and the molten metal is drawn off every twenty-four hours. It is then cast into ingots or "pig" aluminum. After melting and recasting, the "pig" is now ready for the many uses to which it is put.

THE METAL

The metal is silvery white in appearance and very light in weight. Its weight is only one-third of that of iron, copper or tin and one-fourth that of silver. It can be drawn into wire and rolled into sheets. It can be forged, hot or cold, stamped, shaped or polished. It does not tarnish or corrode when exposed to the air and is not affected by water.

ALLOYS

Aluminum unites easily with most of the metals except lead and antimony. Combined with iron, copper or zinc it forms light, strong alloys of great industrial value. Often a metal of great value is combined with a harder one of inferior value to increase its strength. This is called an alloy. Gold and silver coins are alloys. If the coins were made of the pure metal alone they would wear out quickly. The gold coins of the United States are of the standard fineness of 900 parts of fine gold and 100 parts of copper alloy, of which not more than one-tenth may be silver. The silver coins are made of silver and copper, with 900 parts of pure silver and 100 parts of copper.

Of the aluminum alloys the most important is an alloy of aluminum with eight per cent. copper. This alloy is used extensively for automobile castings and parts of aeroplanes and hydro-aeroplanes.

Aluminum bronze, which is an alloy of copper with ten per cent. aluminum, is the colour of gold. It is used for propellers because it is very strong and does not corrode.

USES

One of the most common and well-known uses of the metal is for cooking utensils. Its lightness, toughness, non-poisonous, non-rusting and hard-wearing properties especially fit it for this purpose. It conducts heat so quickly that cooking in these vessels is very quick and scorching almost impossible. Besides those cooking utensils used in the home, aluminum boiling pans are now used in food, candy and soap factories, as well as in breweries and chemical plants. Because of their strength, lightness and cleanliness, canteens or water bottles, made of aluminum, were carried by the soldiers in the European war which engaged the world.

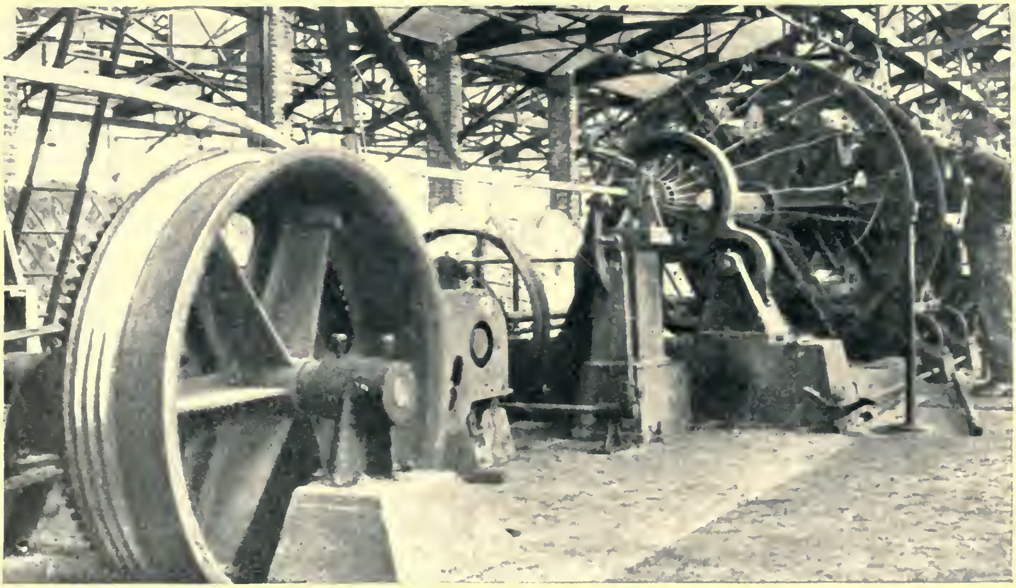
Aluminum cooking utensils are either cast in sand moulds and then polished, or they are stamped or spun from sheet aluminum.

The sheet is also rolled into aluminum foil, which is used for wrapping, like tin foil. The metal is ground into powder which is used for paint. As the powder burns very readily it is also used for flashlight purposes and fireworks.

It is successfully used in lithography instead of the heavy, fragile, scarce and variable Solenhofen stone, for it renders quick printing on rotary machines possible. On account of its sonorous qualities it is used instead of wood for the frames of snare drums, and instead of copper for the kettles of kettledrums.

Aluminum is used extensively in the steel industry. A small quantity added to the molten metal makes the steel sounder, and therefore stronger.

Large quantities of aluminum wire are used in the manufacture of ammunition. A small aluminum tip is placed in the end of each bullet.



Aluminum cables are often used for carrying electric power. This picture shows a cabling machine which unites many single aluminum wires into cables. The single wires are first wound on bobbins or spools and placed in the machine. Notice the large wheel in the background. The bobbins are mounted in this large wheel. As it revolves the single wires pass through the rim of the wheel and are carried down to a much smaller wheel where they are formed into one cable. This cable passes on to the large wheel in the foreground. The finished cable is wound on large wooden reels or spools shown behind the machine and is now ready for shipment. You may have seen reels of cable on the street where conduits are being laid.

The average automobile uses about 200 pounds of the metal, for the bodies, hoods, mud-guards, engine-parts, tread-plates, running-boards and other parts are made of it. The metal is largely used also in the manufacture of gasoline engines and apparatus for aeroplanes. Aluminum cable is extensively used for transmitting electric power from the power plant to distant points. Electric power from Niagara Falls is carried to towns 250 miles distant on such cables. The lightness and strength of the metal make it desirable for surgical instruments.

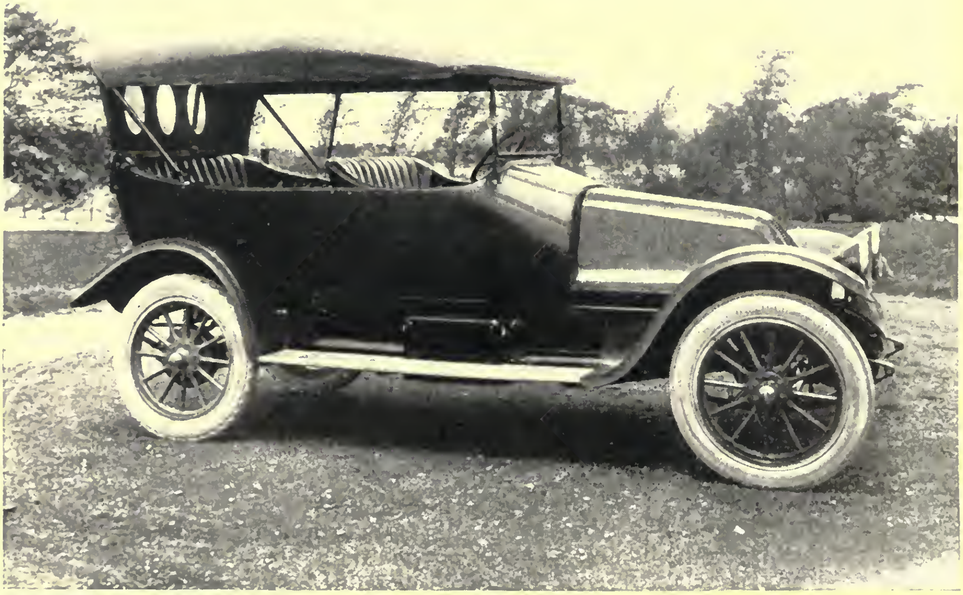
For a number of years the Germans and Austrians have used aluminum in the construction of the fuses of their shells, the canteens, pots and cups of their soldiers and the frames of their Zeppelins. Some of the fuses are made entirely of aluminum, while others are composed of aluminum and brass.

Great quantities of the metal are also used in some air-cooled machine guns, both on account of its high heat conductivity for radiating purposes and also on account of its lightness, which makes the gun easy to carry. One type of air-cooled machine gun uses approximately eighteen pounds of aluminum.

PRODUCTION

The most important factories are in Europe and America, but in 1898 the manufacture of aluminum utensils was begun at Madras in India.

In America the manufacture of aluminum was begun near Pittsburg in 1888 and a few years later the operating company, now the Aluminum Company of America, was the first to use the power of Niagara Falls for electro-chemical purposes. Electric power is such an important factor in the process of manufacture that the manufacturing plants must be located where cheap power is available.



WHERE MUCH ALUMINUM IS USED IN MANY PARTS

Strength and lightness are desirable in a motor car, and both qualities are secured on the better class of cars by the free use of aluminum. The hood, the sweeping curves of the body, and many parts of the engine are made of this wonderful metal. The strength and the rigidity of steel can be secured with much less weight. As much as 200 pounds of aluminum is used in the construction of many cars. If steel and copper were substituted this weight would be much increased with no additional advantage.

Besides those at Niagara Falls, the Company operates large plants at Massena, New York, Maryville, Tennessee, Badin, North Carolina,—which was partly constructed by a French company,— New Kensington, Pennsylvania, Edgewater, New Jersey, Shawenigan Falls, Quebec, and Toronto, Ontario.

In the United States the output in 1883 was 83 pounds, in 1913 it had increased to 70,000,000 pounds, and in 1916 to 150,000,000 pounds.

In Europe the production increased even more rapidly than in America for in 1911 it had risen to 100,000,000 pounds.

When we compare the production of aluminum in the United States with that of iron which is several hundred times as great, the quantity seems very small. It is also small when compared with the production of copper or lead, but the production of none of these other metals is increasing with the rapidity of aluminum. Increasing cheapness of production, as the process is improved, will extend the uses and increase the demand. For example, copper weighs more than three times as much as aluminum, and the latter, if less than three times the price of copper, has the advantage in price, where either metal can be used equally well.

Saluting the Lighthouse Keeper—from the painting by Thomas Graham

LIGHTHOUSE BUILDERS AND LIGHTHOUSE KEEPERS

MEN WHO BUILD AND MEN WHO WATCH IN LONELY TOWERS IN PERILOUS PLACES OF THE DEEP

A VACATION by the sea seems scarcely complete unless there is a lighthouse in sight. It is a pleasant thing on an idle summer day to lie at ease and admire the strength and beauty of the building that crowns a bold headland, or of some stately tower that rises straight out of the water of the sunlit sea. It is pleasant too to sit on the deck of an ocean steamer and look for the light that tells us that we are approaching the land of our dreams, or, homeward bound, to watch for the welcoming rays of the lights of our own land. And it is more pleasant still, if we are at sea on a stormy night, to know that even then the light shines out, that flashing, or wheeling, or shining with a steady beam it will not fail. In narrow seas, or off a treacherous coast, where angry waves strive to drive the vessel from her course, and strong currents try to drag her to destruction, the beacon light throws a friendly warning. Miles away the captain sees the signal, and guides his ship away from the threatened danger. It is then that the seafarer breathes a prayer of thankfulness and of blessing on the lighthouse and its faithful keepers.

But much as we may admire it, and thankful for its guiding light though we may be, we seldom stop to think about the building of a lighthouse, or of the faithful watchers of the light. And yet, the building is often a marvel. How did a castle-like structure come to stand on that lonely rock? Who built a strong tower on this desolate sandy island? How did that stately edifice grow up out of the waves of the sea? These are questions we seldom ask, and yet these sentinels of the deep are, many of them, marvels of engineering skill. Some of them have been built at the risk of the lives of faithful workmen, and they are manned by men, whose heroism is often recorded only in the dry pages of an annual report. The value of the work done by these men cannot be overestimated.

WHERE LIGHTHOUSES ARE BUILT

Where it is possible, the light of course is placed on the mainland. This means that the keeper can live at home with his family. He is provided with a comfortable house; he generally has a garden, and in the United States, the government provides him with free seeds. In fact the keeper lives the life of an ordinary citizen, and often only one man or even, in some places, a woman, is required on a station to keep the light. The work of building is much easier too, and of course much less expensive. But the most famous lighthouses in the world are built miles out at sea, where ragged reefs, or jagged rocks, or treacherous shoals have destroyed many a good ship, and the task of building a tower in these places is a

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task to awe the stoutest heart, and tax the utmost skill that man can bring.

HOW THE TOWERS ARE BUILT

The first landing on one of these dangerous spots is a feat which often requires skill and patience. It took six months of patient waiting before the first landing could be made on the terrible Tillamook Rock off the Oregon coast. The landing must, however, be made before plans are decided on because these must in a measure depend upon the exact position of the site selected. Once the site is surveyed and the plans made skilled workmen are collected, and the materials brought to the nearest possible point for preparation. In these later days concrete, reinforced with steel, is sometimes used, but when the tower is built of stone, all the cutting must be done at the nearest convenient point. The stones must be carefully prepared, by exact measurements and made ready to swing into place. In most cases they are made to dovetail into each other above, below and on the sides. Most of the well known towers are round and taper toward the centre with a slight outward curve toward the top. There are differences of course in design. Some towers like the famous La Jument light off the coast of France are of octagonal shape. Others again, like some Canadian towers, are hexagonal. It has been found, however, that the round type, which is something like the trunk of a tree, is well adapted to withstand the force of furious tempests.

When all the preparations have been made, the rock must be got ready for the foundations, and this is sometimes a perilous proceeding. At best it is slow work, and a trial to patience, for the men can as a rule work only for a short time on the slippery, wave-swept rock before they are driven away by the rising tide. The lower courses of the tower are not only dovetailed together, but are anchored by heavy iron bolts firmly bedded in holes drilled down through the stones and deep into the rock. In the Minot Ledge tower these bolts were carried up continuously to the twelfth course. The work must be of the most careful kind, and the foundations must indeed be " well and truly laid " if they are to hold the tower firmly in its place against the onslaught of the waves and the outward drag of the deadly undertow. Except for the space required for water tanks, the tower is built of solid masonry for some distance above high water. Thus the Minot Ledge tower is all but solid for forty feet, and the Fastnet rises 56 feet before an opening is reached. Above the solid portion come the oil room, store rooms and living rooms for the keepers, and above all is the huge lantern to carry which the tower has been built. The building is done in many cases under difficult, and at times under almost impossible circumstances. Part of the rock cutting necessary for the foundation of the Minot Ledge light had to be done under two or three feet of water, for the surface that showed above water was not sufficient for the base of the tower. To get a dry surface for the first courses, a small dam was built with bags of sand around the spot where a stone was to be laid. The water within this little spot was baled out and sopped up with sponges, and the cement was then laid on the dry surface with a layer of muslin on top, and the stone swung into place. The muslin was used so that if a wave curled over the improvised dam, it should not carry the cement off with it.

Until they were able to set up a crane, the men who built the Tillamook lighthouse had to be landed from the supply ship by means of a " breeches buoy " and life line, and every man who landed got a good ducking before he reached safety. The men lived on the rock and at one time the supply ship was prevented for seven weeks, by storm, from reaching them. The men who built the Skerryvore tower, off the coast of Scotland, and the engineer in charge, had to live in a structure perched up forty feet in the air, on stilts. Many times they had to stay within their shelter for days while the sea boiled beneath them, and " for miles around nothing could be seen but white foaming breakers, and nothing heard but howling winds and lashing waves." It was found impossible to carry the men to and fro: landing was too dangerous.

A LIGHTHOUSE BUILT ON SAND

The great Rothersand lighthouse, whose brilliant electric light streams out over the dangerous shoals at the mouth of the River Weser, is built on sand. To carry out this daring feat of building, a huge barrel-like structure was built on shore, towed out to the spot where it was planned to build the tower and there sunk, in a vertical position. Workmen were then lowered to the bottom, and, working in compressed air, dug out the sand so that the caisson sank lower and lower. As it sank additions were built on the upper edge, and the tube, or caisson, was filled with cement to form a solid concrete pillar, of which forty feet go straight down through the sand. The barrel-like caisson was fitted with four floors. Under the lower floor, the workmen dug out the sand and built. Above them the concrete was mixed. The next chamber held the machinery and boilers, above were the quarters for the men, who lived over their work, and on top were placed the cranes used for lifting materials from the boats which carried them alongside. As the pillar of concrete rose, and the height of the tube was increased, these floors were moved. The sand around the foundations is protected by mattresses of brushwood, and hundreds of tons of stone so that it may not be eroded, or eaten away, by the force of the waves. The Fourteen Foot lighthouse in Delaware Bay was built in the same way over a dangerous shoal. Attempts were also made to build a tower over the Diamond Shoal, off Cape Hatteras, but this was found impossible. The force of the waves and the strength of the currents defied all efforts to sink a caisson, and this dreadful danger spot is protected by a lightship.

"SCREW PILE" LIGHTHOUSES

It is not always, however, necessary to build such strongholds. What is known as the "screw pile lighthouse" has been found very useful in many places along low lying shores, and especially along the Atlantic coast of the southern states. These lighthouses are built on stilts — strong iron legs with a screw end with which they are screwed into the ocean bed. Sometimes the stilts are built of reinforced concrete, and the most famous example of this type stands sentinel on a dangerous shoal in the Malacca Straits.

THE LIGHTING OF THE LIGHTHOUSE TOWER

But no matter how a tower is built, it is of small use without its lights. These are of several kinds and different kinds of illuminants are employed. Electricity is now used in some lighthouses; acetylene gas is also used, especially for untended lights; oil gas is the means of lighting chiefly used in both the British Isles and the United States. Oil for the purpose is brought to the lighthouse in large iron tanks and stored in a room near the entrance, from whence it is pumped up to the lantern. Here it is forced into a vaporiser, in the form of spray mixed with compressed air. The lamps are fitted with incandescent mantles, and the vaporiser is often heated by the mantle itself, though for this purpose a small burner is sometimes used.

The light is concentrated by the use of special and very complicated prisms, lenses and reflectors, so arranged that almost none of the light is lost. The rays are bent, and those which would naturally be thrown upwards or downwards are all turned in a horizontal direction. These lights are very powerful and may be seen at a great distance. For instance, the Navesink light may be seen from a liner's deck at a distance of 28 miles. The electric light at Phanier, in France, has a brilliance of 1,270,000 candle power. The engineers of the Isle of May light, off the coast of Scotland, rate it at 6,000,000 candle power when both generators are working. The electric light on Heligoland is said to equal the enormous number of 43,000,000 candles, and the Navesink light is estimated at 60,000,000 candle power. This is a far cry from the 24 poor little candles which lighted the Eddystone lighthouse in its early days.

Except for guiding lights in rivers and harbours, lights are nowadays seldom fixed. Each lighthouse has its own signal so that sailors may know one from the other, and all signals are placed on record, so that there may be no confusion. This is very important, for the lighthouses are not only sentinels to warn of danger, but sign posts to mark the way when a captain has been driven from his course by storm, or has lost his way in a blinding fog. For instance, the light on Minot Ledge spells 143 thus: - ---- ---. There is an interval of a second and a half between the groups of flashes in the larger group, then an interval of three seconds, and then it begins all over again.

Some lights are occulting, that is, the

light is hidden at regular intervals by a shutter mechanism worked by clockwork; some are flashing, like the Minot Ledge light; others again revolve, some lights show different colours and so on, and thus a large number of different signals is produced. The revolving of one of the great lights with its tons of glass and metal is a difficult matter, and requires a special apparatus of great strength and delicacy. A cast iron trough is made in the shape of a ring, the bath is filled with mercury, and on this floats the turntable which carries the lenses. Smaller revolving lights are still revolved on a turntable with ordinary ball bearings.

All this mechanism requires very careful attention. The windows of the lantern must be kept shining and bright. The lamps must be kept scrupulously clean; from the tiniest piece of brass work to the complicated lenses and great reflectors everything must shine. The writer remembers as a small child being taken to see a lighthouse, and carrying away the impression that the gold and crystal in heaven must shine like that. The heavy clockwork must be wound at night at regular intervals. A careful watch must be kept from the lantern gallery, and if even a slight mist appears the man off duty is awakened to set the fog signal at work. In the morning, the windows are shrouded, in many cases, by heavy coloured curtains, so that the tower gives a definite warning by day as well as by night.

THE LONELY LIVES OF LIGHTHOUSE KEEPERS

Then what of the lives of the men who must live in these lonely places to watch and tend the light! Unless by accident, a man is never left alone in one of these places. Usually there are two men on duty at the light, sometimes three, and in very lonely and difficult places four. Provision is made for their families to live at the nearest place possible, and every effort is made to relieve the loneliness. Phonographs have been installed in some places, and small libraries are sometimes provided — an appropriation of $1,000 for this purpose was made by the United States in 1915. At its best, the life is desperately lonely. It takes a brave man to live, for example, in the Skerryvore lighthouse when the seas, lashed by the tempest, shake the tower to its foundations almost, and the waves wash up around his feet as he clears the windows of the lantern from the snow that would obscure the light. It is difficult almost always, and sometimes impossible for weeks at a time to relieve the men on duty at these places. Landing from a small boat is never easy. In some cases entrance has to be made by climbing the ladder direct from the boat to the entrance. Many times the men have the thrilling experience of landing on the rock and being taken off it by means of the crane rope which lands the supplies.

Perhaps the greatest hardship is the lack of exercise. A man can stand a great deal of loneliness as long as he is able to come and go where he pleases; but the feeling of imprisonment caused by the lack of room to move about is hard to bear. Of course there is a great deal of work to be done. As we have seen the lights need constant attention. Meals must be cooked, every part of the tower must be kept most scrupulously in order, clothing must be kept clean, and the men are expected to be ready for inspection without warning. Then there is painting to be done, and small repairs to be made — the officials must all be handy men. But when all is done there is much time to spare, and over everything hangs the brooding silence, except for the sounds of the ocean, whether it moans in summer calm or mounts to the shriek of winter madness.

THE STRENUOUS LIFE ON A LIGHTSHIP

Life on a lightship is not so lonely perhaps, as in one of these isolated lighthouses, but the hardships are greater. Here the crew never numbers less than seven, and in times of storm all their efforts are required to keep the vessel at her moorings. So difficult a feat is this that the master of the lightship at Cape Charles was mentioned in the report for 1915 for having accomplished it in a heavy storm. The Diamond Shoals Lightship was once driven right over the shoal and on to the beach miles away. To get her off a deep ditch had to be dug to float her back to the sea. When she was afloat a powerful dredger carved a way through the sands of the shoal and was followed through this channel by the lightship, the sand closing after them as they went.

WIRELESS TELEGRAPHY IN LIGHTSHIPS AND LIGHTHOUSES

The value of wireless telegraphy to a lightship was recognised as far back as 1898. In that year, a wireless apparatus was installed on the lightship on the East Goodwin sands, off the southeast coast of England, so that her crew might be able to communicate with the South Foreland lighthouse, twelve miles away, a great distance at that time. A long list of lightships is now provided with this means of communication. It is very valuable, not only in case of accident to the ship or crew, but also in relieving the monotony of the men's lives.

"Wireless" is also used in some lighthouses. The Fastnet sends news of ships passing to and fro between this continent and Europe. The keepers at the lonely light at Belle Isle are able to speak to the outside world by this means, and so are the men on Sable Island, for these places are utilised as radio stations. Other lighthouses are equipped in the same way, and among them some on the coasts of Japan, which is in no way behind its western neighbours in the lighting of its rugged coasts.

THE MINOT LEDGE LIGHT

BELLS AND WHISTLES THAT TELL OF DANGERS THROUGH THE FOG

Every lighthouse and lightship has its own fog signal, for even the powerful lights of the modern lighthouse are not always able to penetrate a thick sea fog. Generally the fog signal is made by a siren wherever it is possible to produce steam to work it. Sometimes, however, a bell is still used. Bells are also used as warnings of unlighted shoals, though whistling buoys are now often used for this purpose either alone or in conjunction with a light, usually an acetylene lamp.

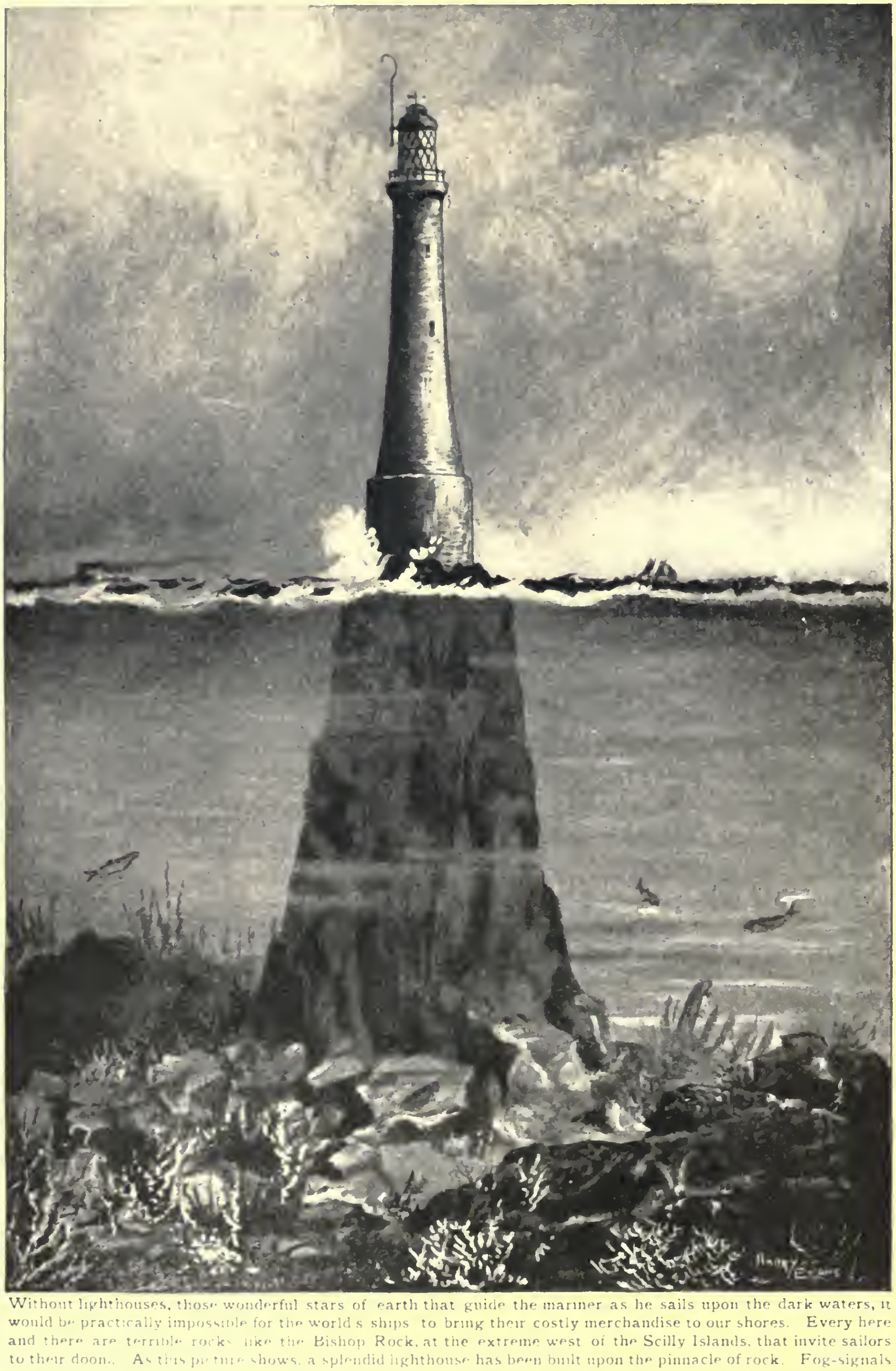
UNTENDED LIGHTS

The use of untended lights has grown of late years. Numbers of them are found in lonely, unfrequented places where it would be cruel to ask men to live. The science of lighting has so greatly advanced that these lights may be left untended for weeks or sometimes months. The light burns all this time, or it is lighted by clockwork at regular hours, or, more remarkable still, by a wonderful Swedish invention, the aid of the sun is called in. As the sun rises and descends its increasing and decreasing light works the valve which controls the gas, and actually lights and extinguishes the lamp.

"WIRELESS" WARNINGS

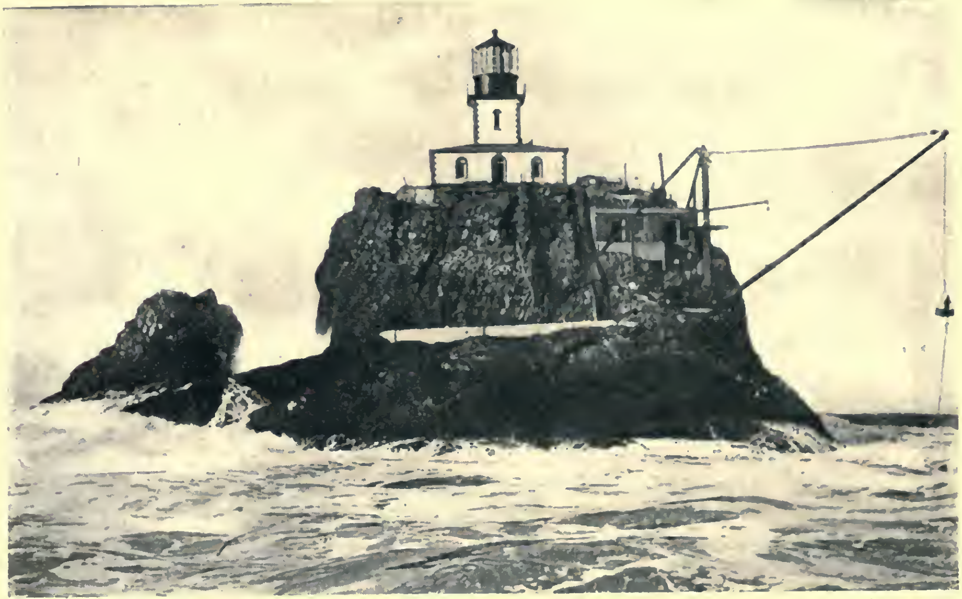
But science has gone yet farther in the effort to safeguard shipping. We all know the saving of life that has been accomplished by the use of wireless telegraphy on ships. It is now proposed to use this means to warn ships of the vicinity of dangerous coasts. In 1914 the French government began the erection of towers near Brest, and near the port of Havre, with the idea of throwing out waves of sound, each tower having its own definite signal. The great advantage of a wireless system is that it is not affected by fog, however thick the fog may be. The wireless apparatus for use in these novel lighthouses is designed to run without attention for thirty hours at a time.

THE FOUNDATIONS NOT MADE WITH HANDS

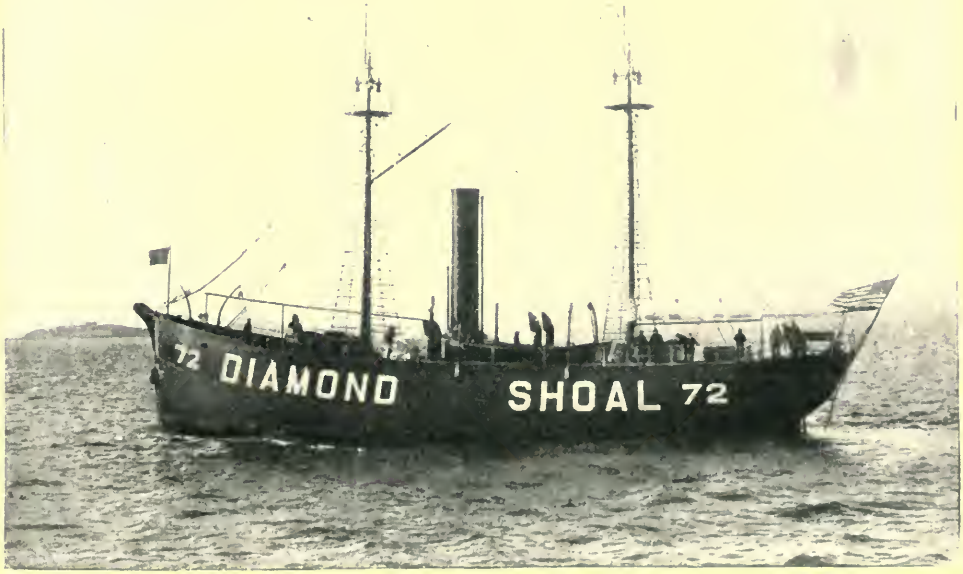


Without lighthouses, those wonderful stars of earth that guide the mariner as he sails upon the dark waters, it would be practically impossible for the world's ships to bring their costly merchandise to our shores. Every here and there are terrible rocks like the Bishop Rock, at the extreme west of the Scilly Islands, that invite sailors to their doom. As this picture shows, a splendid lighthouse has been built upon the pinnacle of rock. Fog-signals are exploded on the curved iron at the top so that the shock may not affect the lighthouse itself. The Bishop's Rock is the most exposed of all the world's lighthouses, and has had to be more strongly built than any.

LIGHTS THAT SHINE FROM ROCK AND SHOAL



The Tillamook Rock light, the most important station on the Pacific coast, is an example of a square built lighthouse. Thirty feet of the rock's crest were carefully blasted off to provide a sound foundation, and this gave space for ample quarters for the men. The rock is so lonely and so difficult of access in bad weather that four men are always stationed there. The lantern was once smashed and the light extinguished by a mass of rock which was torn from the islet and flung, by the waves, on top of the dome.

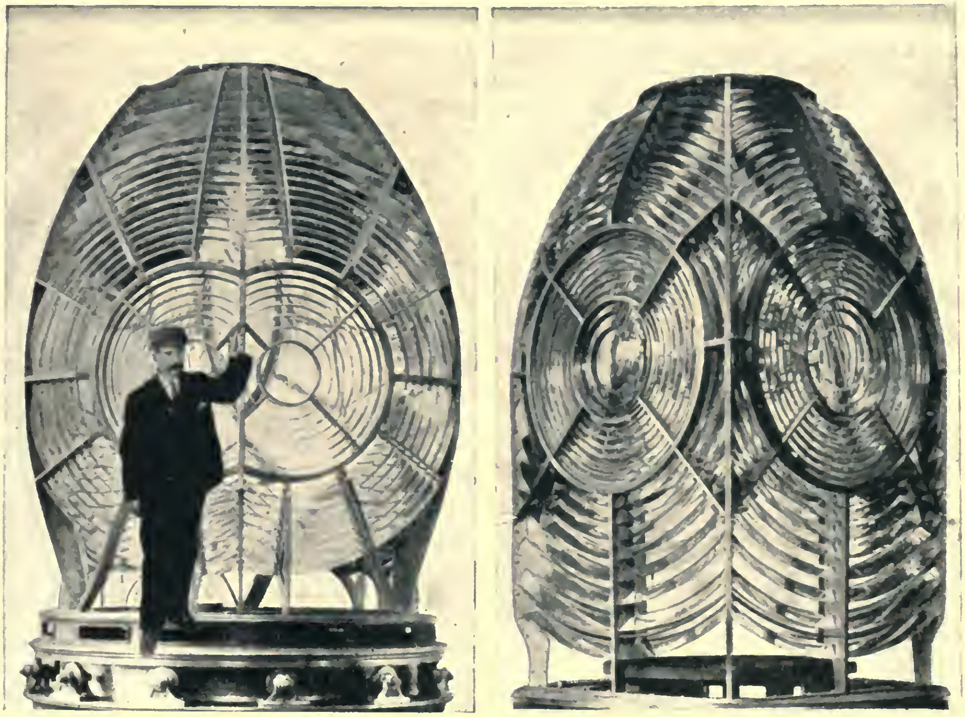


This is a picture of the lightship that gives warning of the terrible Diamond Shoal, off Cape Hatteras. So dreadful are the storms that rage along this lonely coast, and so frantic the currents that race wildly round the headland that the place is known and feared by seamen the world over. The danger is so great, that the lightship is moored over four and a half miles outside the shoals, so that in case the moorings snap, the men have a chance to save her and themselves from destruction. The ship is driven by steam and is lighted by electricity.

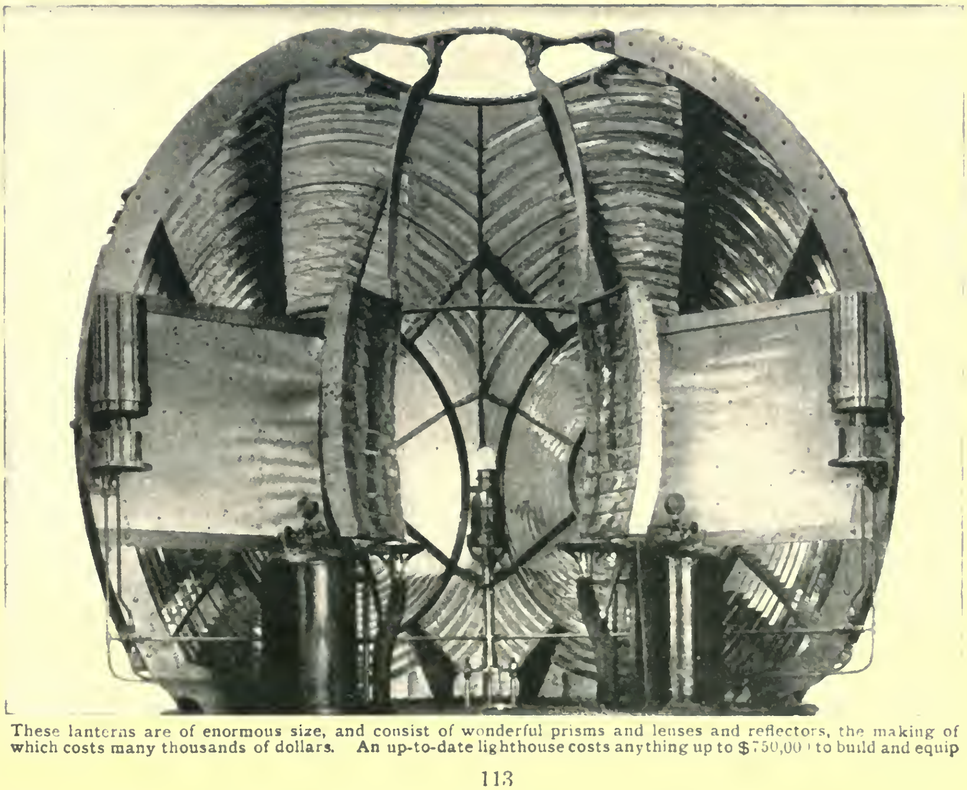
THE LIGHT OF SIXTY MILLION CANDLES

The wonders of a lighthouse light are quite beyond our comprehension. Its beams shine or flash out across the darkness so that the mariner can see them, in some cases, while he is between thirty and forty miles away; and in some of the latest lighthouses the light given out from the lantern is equal to as many as sixty millions of candles.

THE SHINING WINDOWS OF A LIGHTHOUSE

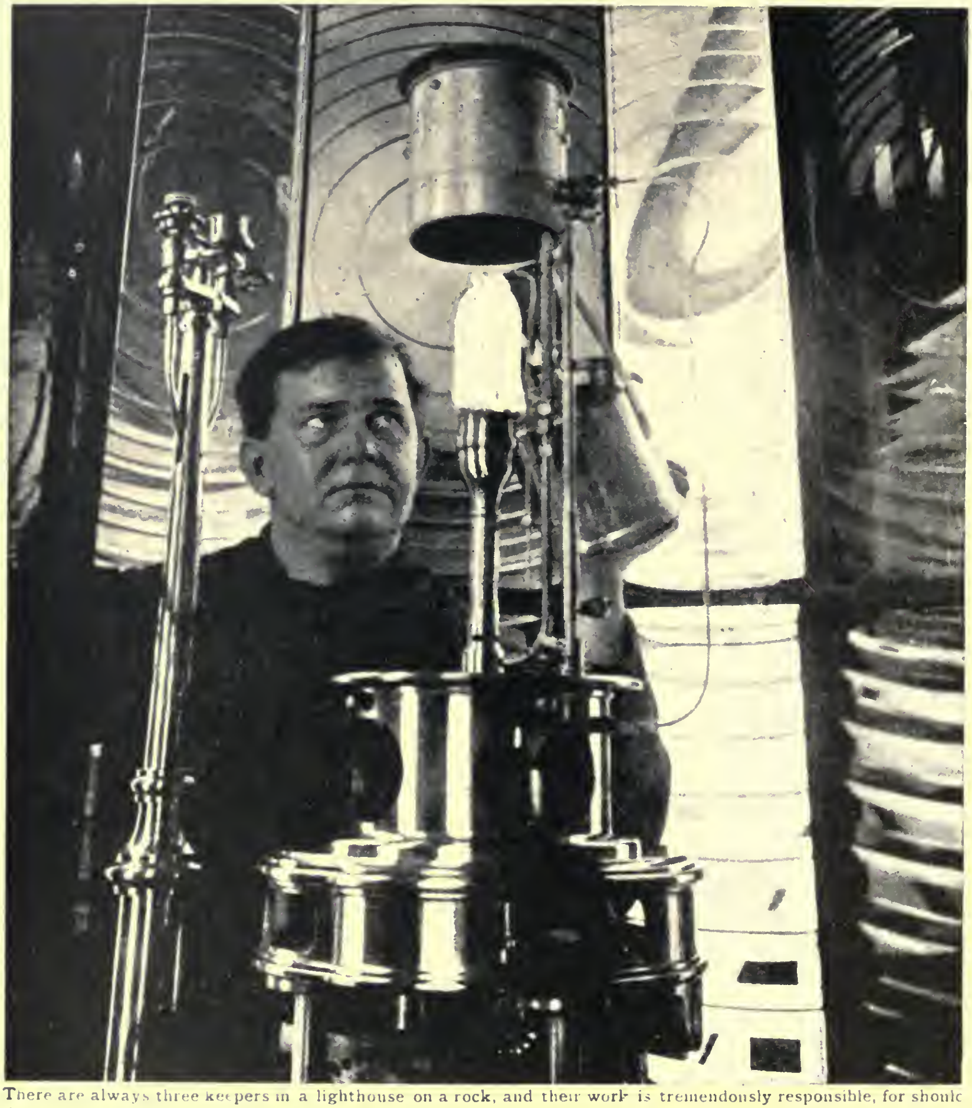


The most wonderful improvements have been made in recent years in the lighting of lighthouses. Not only have the lights themselves been made thousands of times more powerful than those formerly used, but marvellous lanterns, like those on this page, made up of complicated lenses, increase the power of the light many thousands of times.



These lanterns are of enormous size, and consist of wonderful prisms and lenses and reflectors, the making of which costs many thousands of dollars. An up-to-date lighthouse costs anything up to $750,000 to build and equip

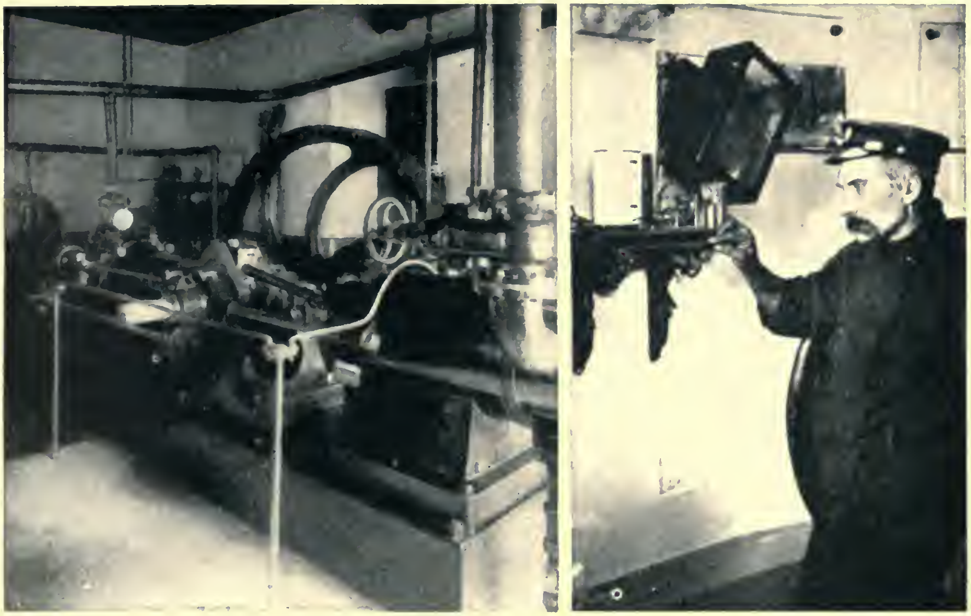
THE MEN AT WORK IN THE LIGHTHOUSE



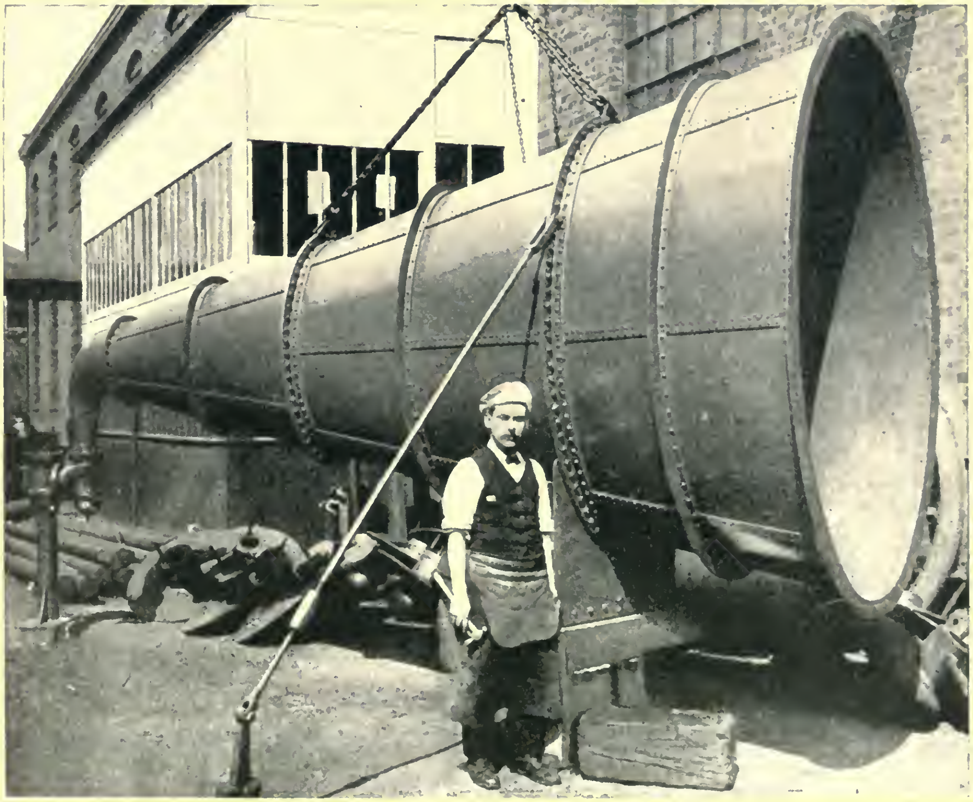
There are always three keepers in a lighthouse on a rock, and their work is tremendously responsible, for should they allow the light to go out only for five minutes many ships might be wrecked. Here we see the keeper in the daytime getting the lamp ready for night. The greatest care has to be exercised to keep the light brilliant.

The lighthouse-keepers not only have to see that their lamps burn brightly at night, but, as the man is doing in this picture, they keep a sharp look-out by day for vessels in distress and for any fogs that the wind may blow up.

THE GREAT HORN THAT SOUNDS AT SEA



To warn ships in foggy weather there is a foghorn, or siren, and in some lighthouses three great gas-engines like that on the left are used to blow the horn. The man on the right is recording the time during which the foghorn is sounded.

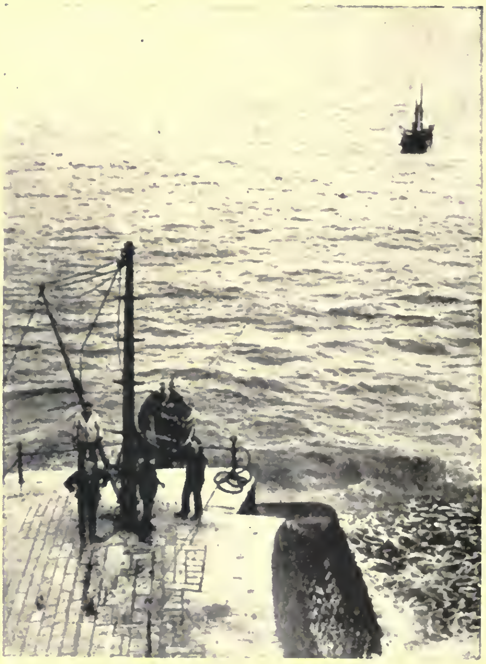


Here is a monster foghorn for a lighthouse, one of the largest size that is made. It can be heard for miles, and is built upon an elaborate scientific principle. The horn itself is, of course, to increase the sound made by the siren.

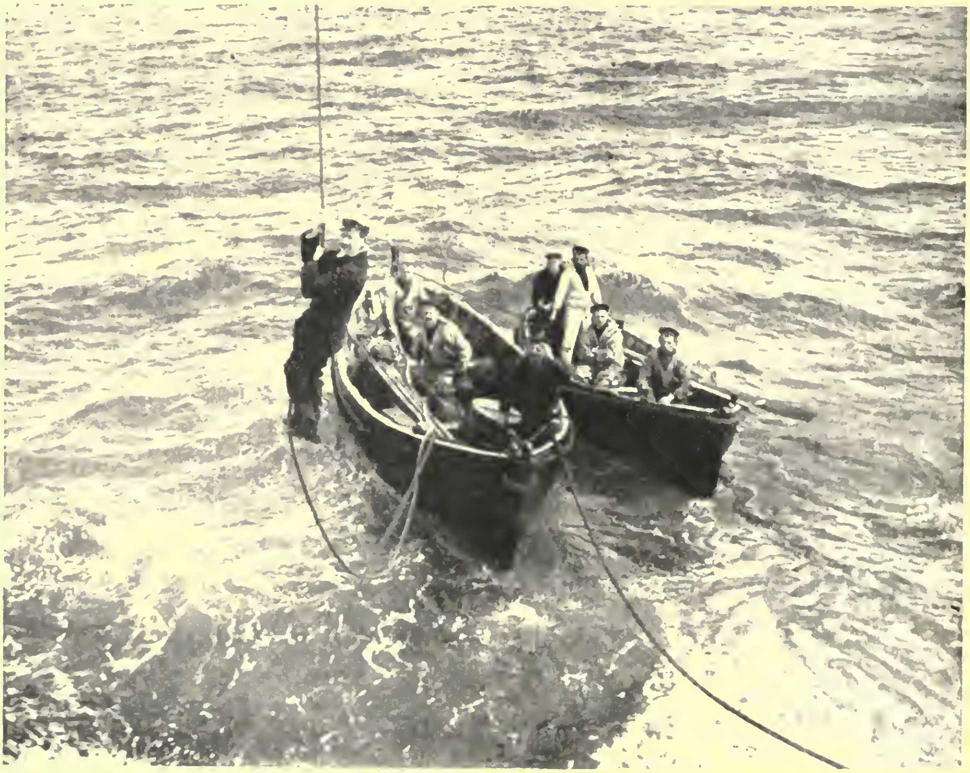
The pictures on this page and on page 109 were taken at the lighthouse works of Messrs. Chance Brothers, Ltd., by whose courtesy they are [illegible]

CHANGING GUARD AT A LIGHTHOUSE

Life on a lonely lighthouse is very dull, and the men look out keenly for the approach of the relief ship.



The ship is unable to approach very near to the rocks, and the men have to row from the ship to the lighthouse.



When the boats get near the rock on which the lighthouse is built, it is often impossible for the men to land in the ordinary way and they have to be hauled up, as shown in this picture. In stormy weather this is very dangerous.

THE STORM THAT BEATS ON A LIGHTHOUSE

The storms that beat against a lighthouse are terrible in their power, and communication, even by a life-line, as seen in this picture, is often cut off for weeks together.

The snow and ice collect upon the glass of the lantern and, at the risk of being blown away by the terrific winds, the lighthouse-keepers have continually to wipe it off.

This picture, painted by Turner, shows the Eddystone Lighthouse in a gale. The first Eddystone Lighthouse was blown away in a single night, and at the Bishop Rock Lighthouse, shown on page 110 the great fog-bell, weighing more than a quarter of a ton and hanging a hundred feet above the sea, was carried away by the angry waves.

A STERN AND ROCK-BOUND COAST

THE LIGHTHOUSE BEHIND WARNS THE SHIPS AWAY

THE STORY IN A LACE CURTAIN

THE MYSTERIES AND HISTORIES AND TRAGEDIES THAT LIE THERE FOR ALL OF US TO SEE

THE DARK TALE OF THE CURTAIN THAT HANGS IN THE LIGHT

The lace curtain that hangs at the window, beautifying the cottage and adorning the mansion, is so like many millions of similar curtains as to form one of the most commonplace things in our lives. But there is a volume of history behind the curtain at the window which fills us with mingled gladness and shame as we remember it.

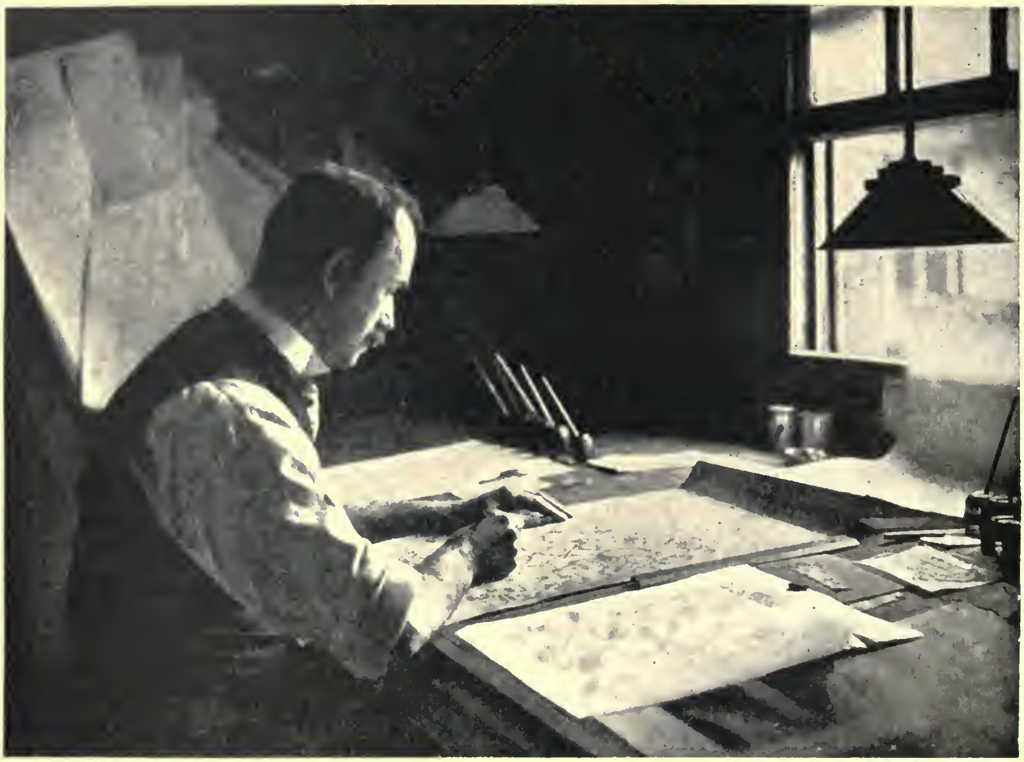
Woven into the pattern of the curtain is the story of far voyages of discovery, expeditions of ruthless conquest, of enslaving of men and women and children, of wars and rebellions, and a frightful chapter of wrongs. And after that comes a chapter of stirring history of brave endeavour and ingenuity, of the making of machines, of the rising of furious men against them, of dire poverty in our own land and in the East when the machine made its way, and, finally, of the success of the machine, and the growth of a vast industry to take the place of a little group of handworkers.

The cradle of the lace curtain, as of the whole cotton industry, was the little ship on which Columbus sailed into the West to find the East. He knew all about the cotton plant, for he had seen the cotton which the industrious Moors had long been carrying to Spain from the far East Indies, and when he found cotton growing wild on the first island at which he landed, Columbus thought he must have come to the western part of India. Of course, the islands were the group lying on the eastern coast of Central America, but he called them the West Indies, and so they are called today, though they should really be called the East Americas, half a world away from the place he thought he had reached. Portugal discovered soon afterwards the sea route to India, and her traders were able to bring to Europe the cotton fabrics made in that land of ancient civilisation. Spain tried to compete against the rival nation by planting cotton in the newly-found America; but Spain could always conquer a country more easily than she could develop it, and it remained for a little band of Englishmen slowly to win both West and East for England. In the words of Carlyle, it was as if the better part of mankind said, "Shall half the world be England's for industrial purposes . . . or shall it be Spain's for arrogant-torpid, sham-devotional purposes, contrary to every law?" England won America, and zealously grew cotton; she won India, and one of the foremost entries in the charter first given to the East India Company to trade with India was the right to deal in Indian muslins and other cotton goods. Then, at last, when England was able to command a cotton supply for herself, she started her own great cotton manufacturing trade, and no longer bought the made-up goods of India. The day of the Nottingham lace curtain was rapidly drawing near, but had not yet arrived, for a hundred years ago the proudest prince could not have been supplied with curtains made by a machine. Before this came about a tragic chapter of history was to be written.

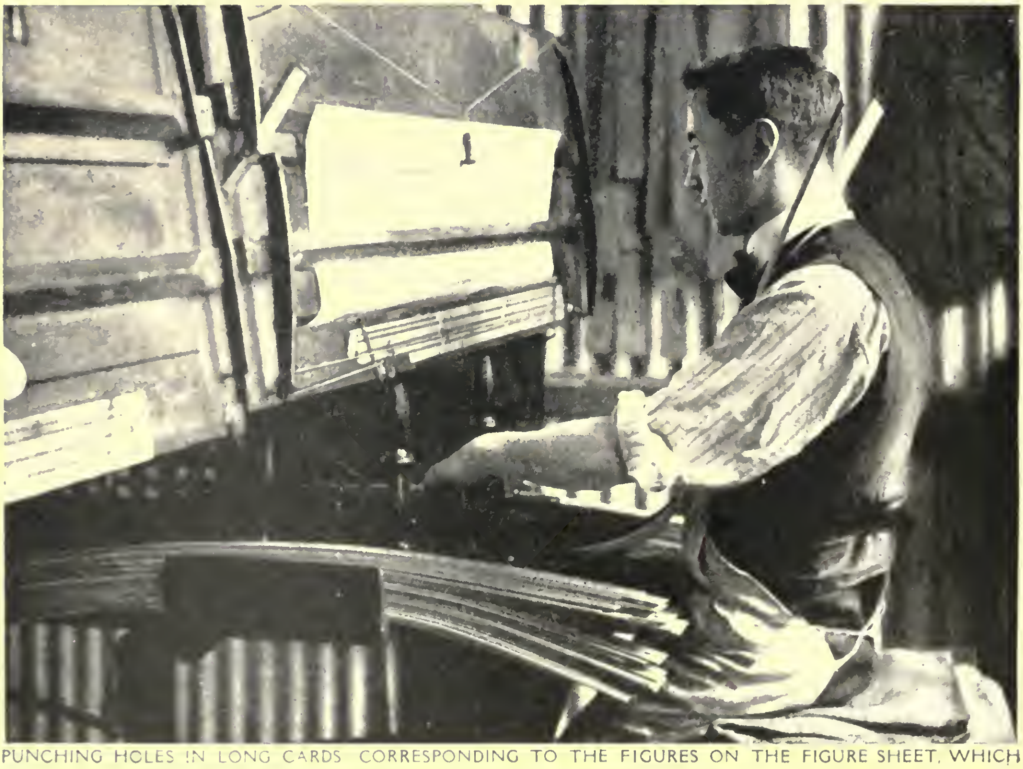
African negroes were taken from their homes and carried as slaves to the American colonies and the West Indies. In the course of a century English and colonial ships carried over two million slaves from Africa to America. These slaves were employed on the farms and plantations and as house servants. At the close of the Revolution, when the Constitution for the new nation was being written, strong efforts to abolish it were made, but without success. In some of the States slavery was not at all profitable, and in these it was voted out. In others people thought they could not get along without slaves. At the time little cotton was grown, for it was separated from the seeds with great difficulty. Five pounds was a good day's work.

Then an extraordinary thing happened. Eli Whitney invented his wonderful cotton-gin, a machine for separating the raw cotton from the impurities

PREPARING THE DESIGN FOR THE LACE MACHINE

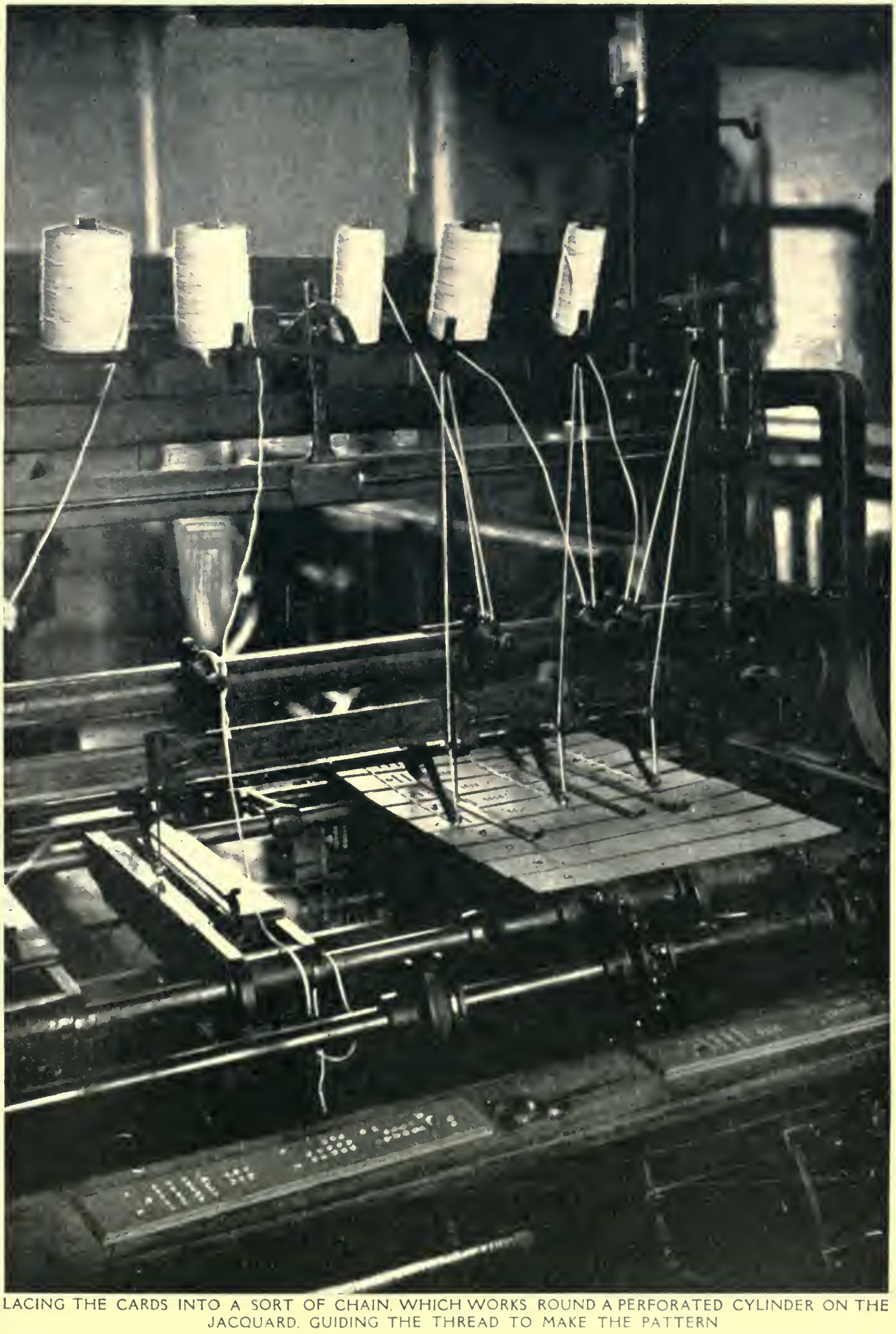


THE DRAUGHTSMAN AT WORK PREPARING THE DRAUGHT FROM THE DESIGN FOR THE FIGURE SHEET



PUNCHING HOLES IN LONG CARDS CORRESPONDING TO THE FIGURES ON THE FIGURE SHEET, WHICH CORRESPOND TO THE PATTERN OF THE LACE

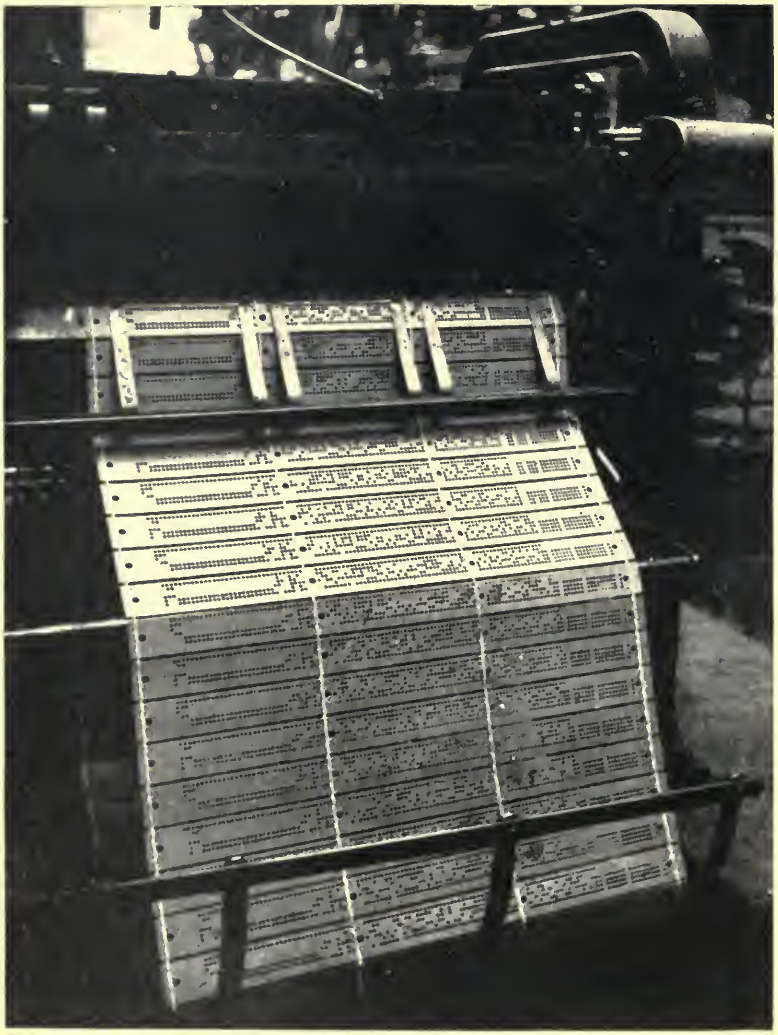
LACING THE WONDERFUL CARDS TOGETHER



LACING THE CARDS INTO A SORT OF CHAIN, WHICH WORKS ROUND A PERFORATED CYLINDER ON THE JACQUARD, GUIDING THE THREAD TO MAKE THE PATTERN

Through the holes in these cards, steel "droppers" rise and fall, so working the steel bars stretching from end to end of the machine, through which the long beams are threaded.

of seed and husk and dirt. That machine could with ease clean a thousand pounds of cotton a day, so that a man or woman engaged in growing cotton became more valuable. This great invention thus unhappily riveted slavery more firmly than ever upon the Southern States, and only after one of the greatest and most terrible wars known to the modern world, the American Civil War, had been fought was liberty given to all the slaves in the United States.



THE WONDERFUL CARDS, PUNCHED WITH HOLES REPRESENTING THE PATTERN, WHICH WORK ROUND AT THE END OF THE MACHINE AND, BY CAUSING THE RISE AND FALL OF LITTLE RODS, GUIDE THE THREADS OF THE PATTERN

By this time a vast trade in cotton manufacture had been built up in England. All sorts of cotton goods were being made in Lancashire, but Paisley, on the one hand, and Nottingham, on the other, started trades of their own, and have never lost them. Paisley to this day makes cotton thread for half the world; Nottingham makes the curtains.

Many clever men worked in secret to build up the trade by making machines for spinning cotton threads from the raw material. James Hargreaves, a man who could neither read nor write, made the first spinning jenny, which enabled men to spin cotton in great quantities without using their hands. The men of that age, however, had a deadly hatred of machinery. They did not realise that machinery was providing them with an enormous supply of material for their labour; they only thought that the effect was to rob them of the work of their hands. And so they gathered together from three or four small Lancashire towns, marched like an army to the house of Hargreaves at Blackburn, smashed his machines and his furniture, and destroyed the factory at which he worked. The poor inventor fled in dismay to Nottingham, where he found a friendly, bright-witted carpenter ready to help him; and these two, the man who could not read or write, and the humble carpenter, started the first little cotton factory in Nottingham. Richard Arkwright followed a little later with his famous spinning machine, and he, too, was so persecuted that he had to flee to Nottingham, where one of the principal streets of the city today is named after him. Then an ingenious clergyman named Cartwright invented the first power loom, and the mob burned down the factory at Doncaster in which he had set up his machines.

Evidently Nottingham treated its inventors better than other towns, or there would have been a very unimportant Nottingham today. Out of the machines that had gone before, a clever man named John Heathcoat produced one to make lace by machinery. It was at once successful, and Heathcoat set up a factory at Loughborough, a little town in Leicestershire; but the machinery-breakers followed him there and broke up all his plant, and Loughborough, which might have been a great town today, remains a comparatively small place.

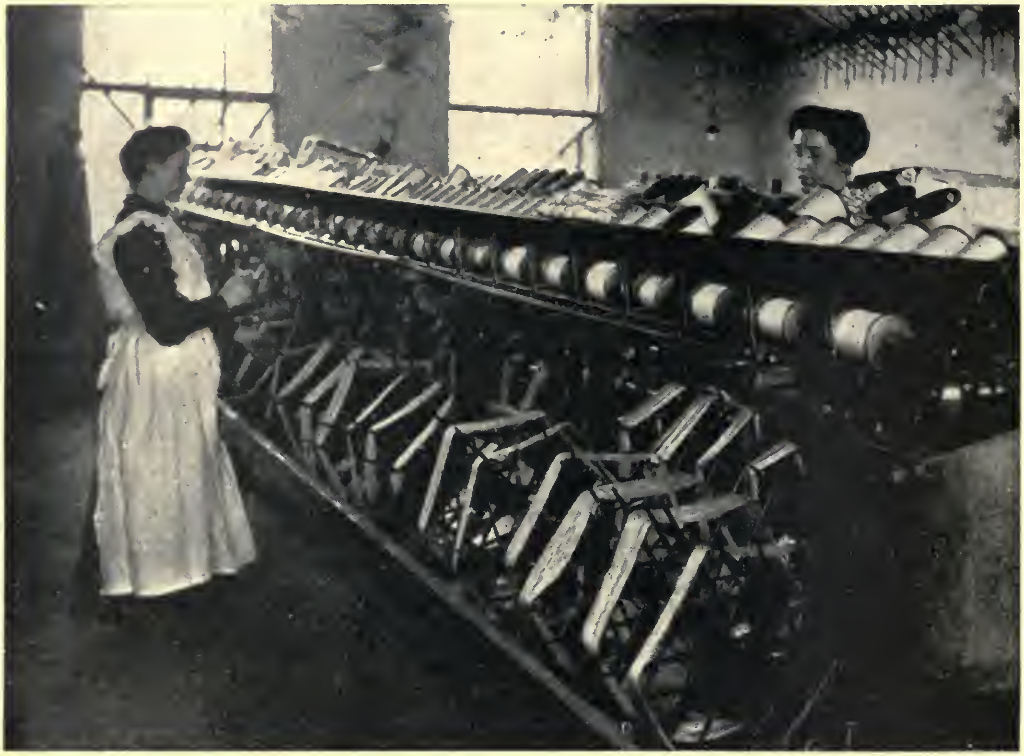
Although Heathcoat's machine was the most complicated known up to that time, it was made still more complicated by John Leavers, of Nottingham, who built a famous machine which is still the foundation of lacemaking. All that has been done since has been merely gradual improvement upon what Leavers accomplished. Of course, there are many machines for work that Leavers never knew, but for the most important part of lacemaking—the finer laces—the Leavers machine, with its improvements, still stands.

It would be impossible to describe the machine in small space, but in effect it is this. From the skein the cotton is wound on to wooden bobbins, from which it is run on to beams—of which there may be 200—or on to brass bobbins, of which there may be 5000. By marvellous mechanical arrangements, strips of card, punched with round holes in accordance with the design, cause little steel rods, or "droppers," to rise and fall, so bringing into play the various items of mechanism which control the run of the thread. The threads from the long beams pass through fine steel bars, which move from right to left, being worked by the little rods. The threads from the brass bobbins are worked from front to back, so that the two threads are being constantly crossed and recrossed in a way determined by the holes in the cards.

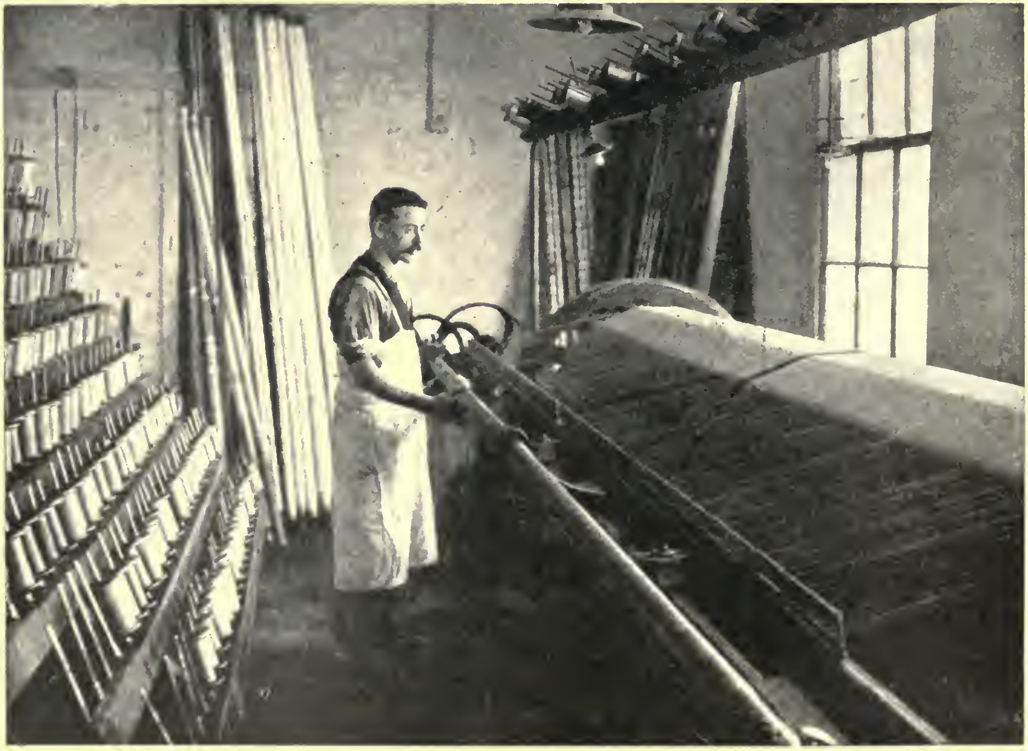
THE IMPRESSIVE SIGHT OF A LACE MACHINE AT WORK THOUSANDS OF MILES OF COTTON UNWINDING FROM THE BEAMS

That, in brief, is the way in which lace is made, though curtains, generally of coarser lace, have slightly different machinery of their own. The finishing is largely done by hand, and there are many processes; but nothing is so wonderful as the making of the lace itself, and the lace machine is often said to be the most wonderful thing that men have made with steel.

WINDING THE THREAD THAT MAKES THE LACE

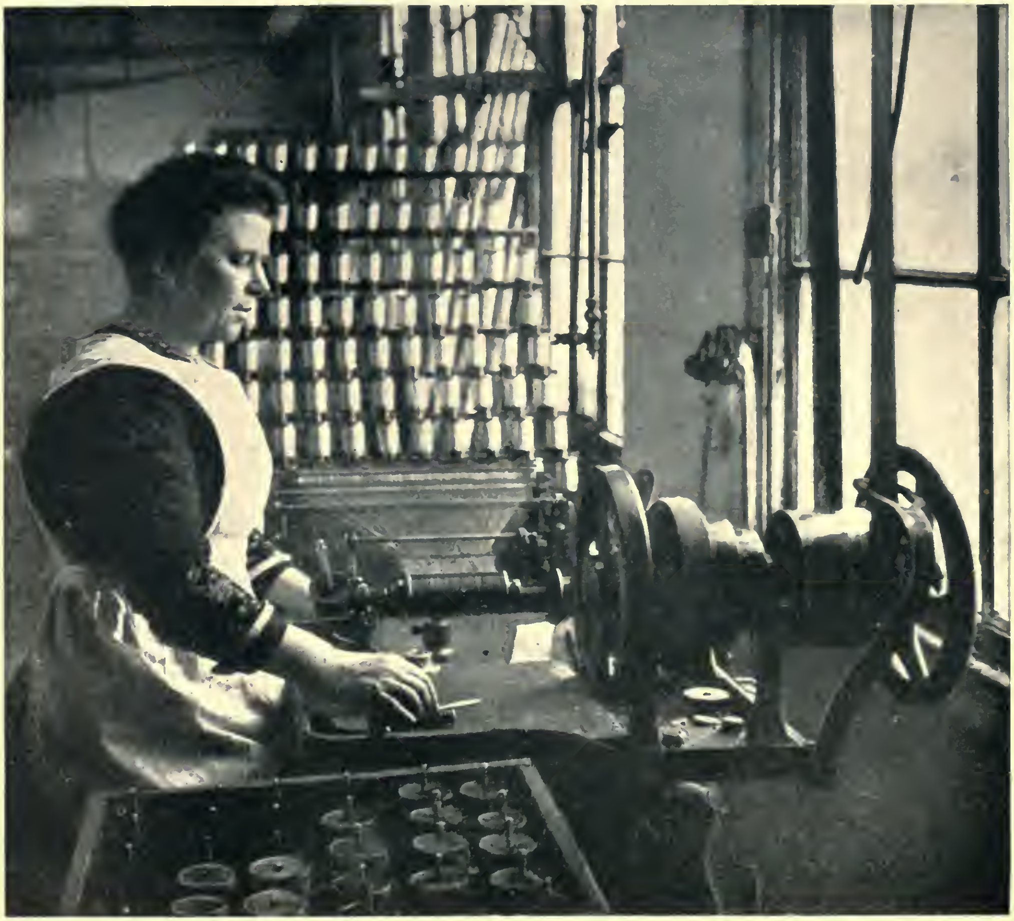


WINDING THE THREAD FROM THE SKEIN ON TO THE WOODEN BOBBINS, FROM WHICH IT IS WOUND ROUND THE LONG BEAMS

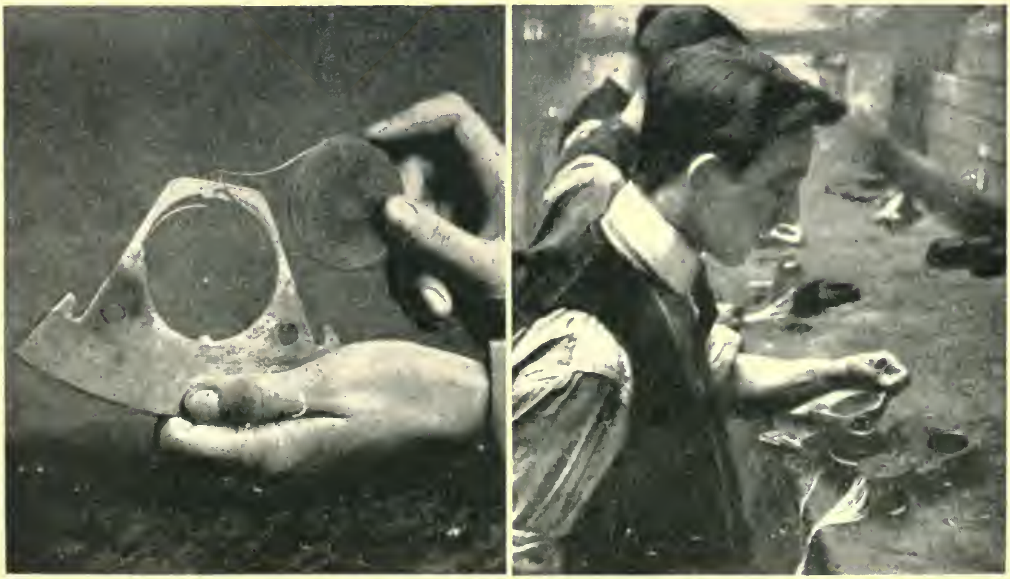


WINDING THE THREAD FROM THE WOODEN BOBBINS ON TO THE LONG BEAMS

THE BRASS BOBBINS WITH MILES OF THREAD

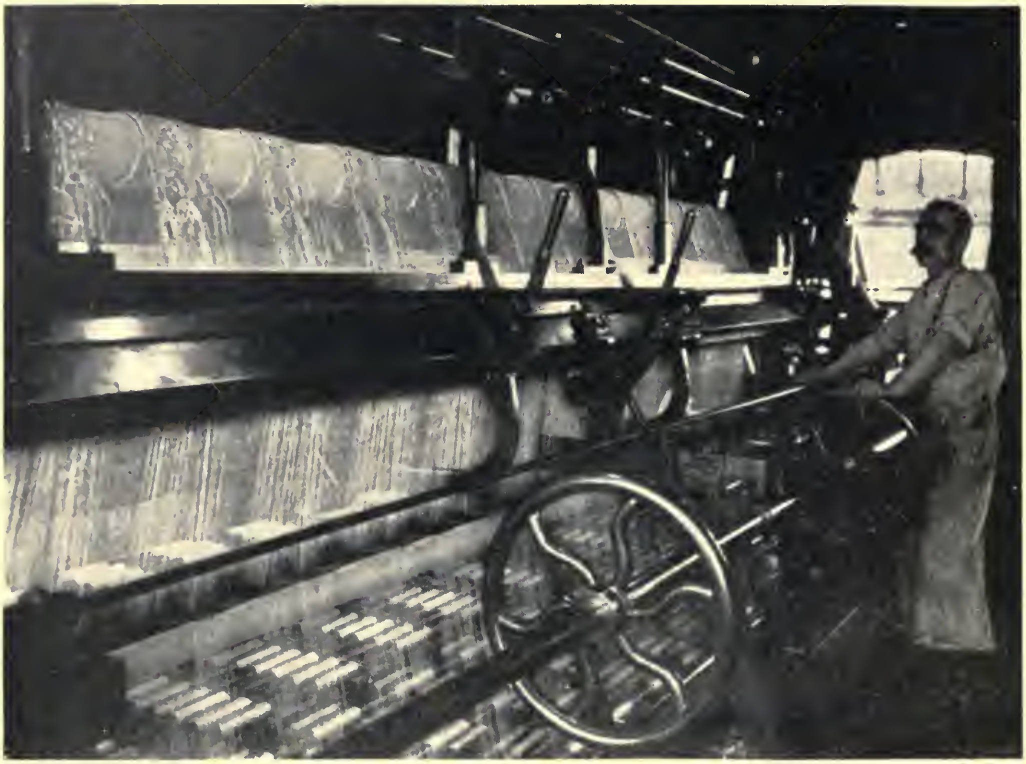


WINDING 80 YARDS OF THREAD ON TO EACH OF 120 BRASS BOBBINS ABOUT ONE-35th OF AN INCH WIDE

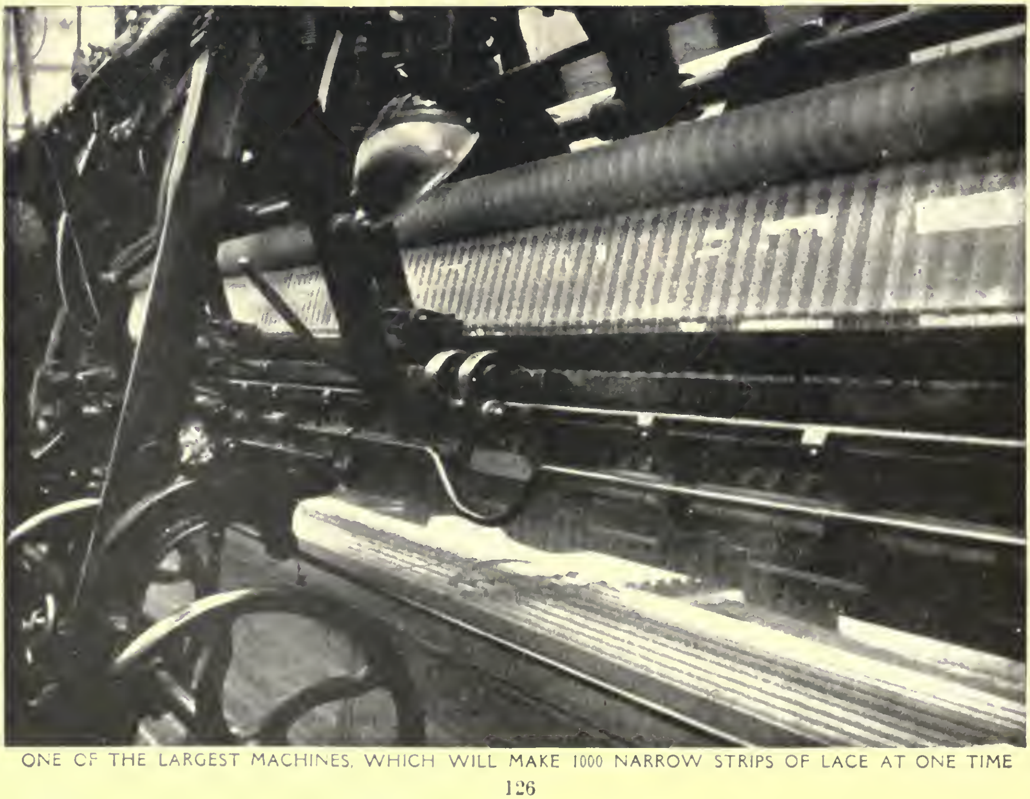


THE MARVELLOUS BRASS BOBBIN WHICH GIVES THE LACE ITS FOUNDATION, SHOWING THE FINE SPRING WHICH HOLDS THE BOBBIN IN THE CARRIAGE AND STEADIES THE THREAD WHEN WORKING

THE TWO LACEMAKERS—MAN AND MACHINE

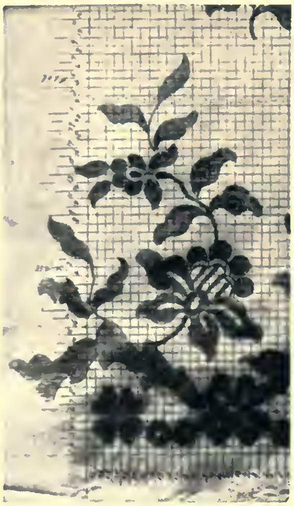


A MACHINE MAKING THE LACE SHOWN ON THE OPPOSITE PAGE



ONE OF THE LARGEST MACHINES, WHICH WILL MAKE 1000 NARROW STRIPS OF LACE AT ONE TIME

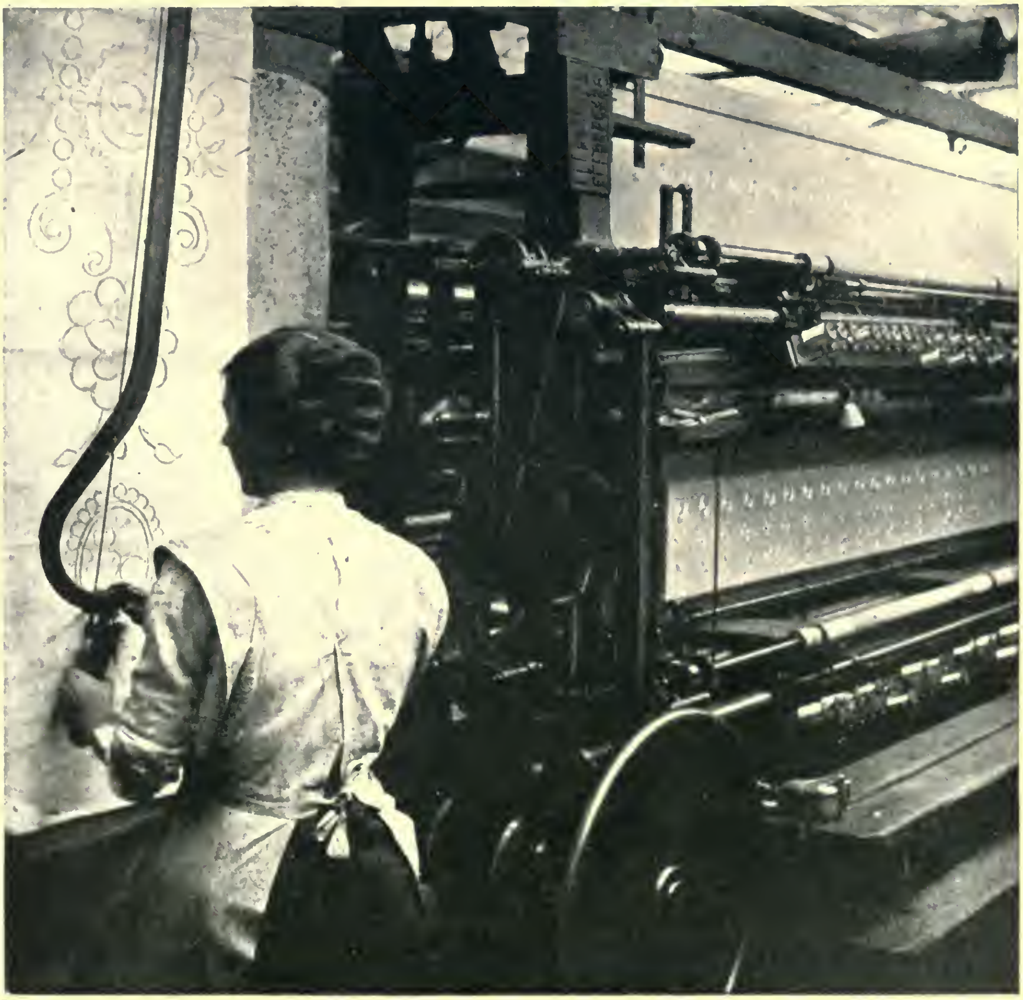
A LACE MACHINE THAT SEEMS TO UNDERSTAND



THE PATTERN SHEET

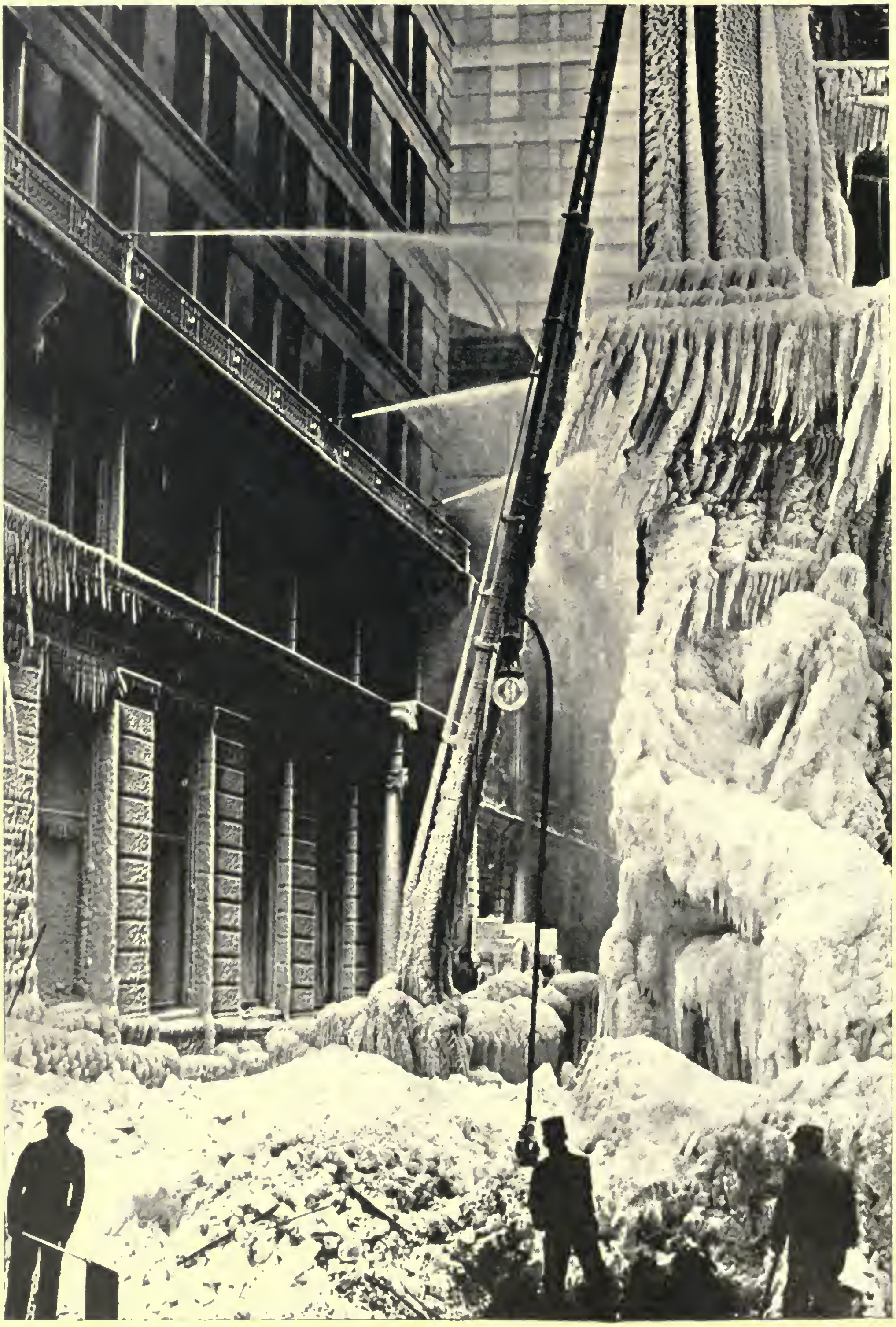
THE SAME LACE ON THE MACHINE

READY FOR A LADY



THE MARVELLOUS MACHINE BY WHICH A GIRL, TRACING A PATTERN ON PAPER AS IN A PANTOGRAPH, GUIDES THE THREAD SO AS TO WEAVE 20 YARDS AT ONCE, WORKING 150 NEEDLES

ALMOST CONQUERED BUT NOT QUITE



Some of the worst fires occur in the coldest weather. Here the fire is almost out, but several streams of water are still playing on the building from lines of hose which have been carried through the building across the street. The hook and ladder truck has been frozen to the ground and almost buried by the ice which formed while the water was being poured into the building. The fire may smoulder for days.

WHEN THE FIRE ALARM BELL RINGS

HOW THE DREADFUL ENEMY IS FOUGHT

WHO has not, at some time or other, felt a thrill of dread upon hearing the clanging of a fire alarm? At any rate there are few to whom it does not bring a quickening of the pulse. The fear of fire is an old one, so deep rooted in the past that small children feel it by instinct, even though they may never have seen a house ablaze.

Fire is one of those elemental forces of nature which man can never quite conquer. To be sure it cooks our food, it keeps us warm in winter and it generates the steam which turns the wheels of all our great industries; nature has offered us no more useful servant than this fiery child of hers. But let the master only turn his back one moment and the slave leaps up in rebellion, hungry to devour and to destroy.

FIRE BECOMES MORE DANGEROUS

It has been to man's possessions, rather than to himself, however, that fire has been so relentless an enemy. While he lived in caves or tents the danger was not so great. It was when he aspired to wooden houses and began grouping them together in towns and cities that the enemy found a vulnerable point at which to attack.

All through the earliest records of history we find accounts of conflagrations that wiped out great cities. For when once the enemy had gained a foothold the people were helpless; all they could do was to gather together as much of their valuables as they could carry and flee to the open country.

THE ROMANS ORGANISE A FIRE DEPARTMENT

It was the Romans who first attempted to offer organised and systematic resistance to these terrible raids. Possibly their experience in fighting their many human enemies suggested it to them; they were the masters, in their time, of the science of military warfare. Probably it occurred to them that the same methods could be employed successfully against the two kinds of enemies. At any rate Rome was the first city to organise a regular fire department, a standing army of fire fighters, which at one time numbered seven thousand, with nothing to do but to respond to the fire alarms. And, strange as it may seem, some of the methods they employed in extinguishing the flames have not been improved upon to this day.

Could we have a moving picture of a conflagration in Rome, two thousand years ago, it would probably present to us a scene not very different from those we sometimes witness to-day in our own modern cities. The houses in the poorer and more populous quarters of Rome were usually built entirely of wood. Each family kept a continuous fire burning on an open altar, in honour of the domestic gods, and so it was no wonder that fires frequently broke out.

SCENE AT A FIRE IN ROME

First would come the alarm; the householder would rush out into the street, shouting. But there would be no alarm boxes to which he could turn. Instead there were men stationed along the streets, at short distances apart, known as "nocturnes." From one nocturne to another the alarm would be shouted along the line until it reached the nearest "castra," or fire house, where the fire companies covering that district would be quartered. Then all the human alarm boxes within hearing would rush to the scene of the fire and become policemen. Just as the police do at our fires, they would drive back the gathering crowds and establish strict fire lines.

Not many minutes would pass; then, above the excited murmuring of the crowds would rise the distant sounds of shouts and the quick tramp of many feet. The nocturnes would rapidly clear an opening through the crowds and through the passage would charge a centurion, heading a company of firemen in metal helmets and leather jackets and trousers. Some would be bearing "siphones," wooden hand-pumps that worked like syringes; others would be armed with axes, hammers, saws and iron bars, while still other groups bore short ladders, so made that their ends fitted and could be clamped together, forming a means of ascent to the tops of the highest buildings.

After these foremost squads would follow the main mass of the firemen, the

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"aquarii," numbering hundreds, each carrying a light earthenware vase. The aquarii would immediately form into chains to the nearest cistern, supplied from the great aqueducts leading into the city, and presently the jars would begin emptying a continuous stream of water in the hand-pumps.

THE FIRE CHIEF ARRIVES

Suddenly a loud cheer would arise from the crowd and a chariot would dash through the passageway, bearing the "prefectus vigilum," the fire chief, who would immediately assume command of the operations against the flames. Surgeons, too, would be in attendance, to care for those who might be injured or overcome by the smoke. There were three attached to each fire house. Not least prominent would be the pillow bearers, each four carrying among them a huge, leather pillow, each pillow at least four feet square and stuffed with feathers. Should anybody appear in the upper windows of the burning building, whose escape by the stairways had been cut off, the pillow bearers would immediately drop their pillows below the windows, upon which the imprisoned inmates of the building might leap. There are expert fire fighters to-day, — one of them at one time chief of the New York Fire Department, — who say that nothing has ever been invented that serves its purpose better than the life-saving pillow of the old Roman fire department.

Last to arrive, but by no means least important, would be the "questionarius," the most feared and respected of all the Roman fire officials. As his title might indicate, even to those who do not know Latin, his business was to ask questions, but to many his questions were anything but comfortable. How did the fire start? Was it accident? For the Roman laws demanded that responsibility must be fixed for every fire. It was the business of the questionarius to fix the responsibility. He established a court of inquiry, even before the flames had been subdued. He could compel testimony from everybody. And if the suspicion of arson was very strong against anybody in particular he would not hesitate to apply torture to hasten a confession. It is only of late years that modern cities in this country have taken example of old Rome and appointed officials whose duties correspond to those of the questionarius; he is known as the fire marshal.

SOME GREAT FIRES OF WHICH WE KNOW

When the Northern barbarians destroyed Rome a great many of her institutions were lost to the world; among them was the organised fire department. During all the dark middle ages men thought more of war and destruction than of saving lives and property from the flames. Great conflagrations were taken as visitations from an angry Providence, as was pestilence and famine. Berlin was destroyed in 1405; Moscow, Lisbon, Venice, Vienna and Copenhagen suffered enormous and disastrous fires. Constantinople was entirely or partly wiped out a dozen times. London was again and again laid waste, notably in the years 798, 1087, 1132, 1212 and in 1666, the last being the "Great Fire," which burned for four days and destroyed 13,000 houses and public buildings covering 436 acres. How helpless the citizens were against fires in those days may be judged from the vivid description of the great London fire handed down to us by Samuel Pepys in his famous Diary. In the hope of checking the onward sweep of the flames houses were blown down with gunpowder across those sections toward which the wind was blowing the flames, that they might have nothing to feed upon.

The great fire of London seems to have waked the people to the need of something at least approaching a fire department. Immediately afterward officials were appointed who must make it their business to devise some means to check future fires. The hand-pump was brought into use again. Fire companies, too, were organised, the members being volunteers, just as they are to-day in our villages and small towns.

FIRES DESTRUCTIVE IN AMERICA

In the American colonies the problem of checking fires was even more serious than in the mother country, for here, because of the vast forests so close at hand, the houses were built almost entirely of wood. One of the first fire companies to be organised in this country was founded in Philadelphia, in 1736. Of the four chiefs Benjamin Franklin was one. Each member was expected to furnish, at his own expense, six leather buckets and two stout linen bags. The buckets, of course, were intended for throwing water on the flames; the bags were used as receptacles for whatever valuables might be saved from the burning buildings. In New York similar fire brigades were organised and it became quite the fashion for the young men of the city to join them. So numerous were the members that they also undertook the duties of a fire police. All through the night members of the volunteer fire companies would patrol the streets of the populous quarters of the city. For this reason they became known as the "Prowlers."

EARLY FIRE FIGHTERS IN NEW YORK

So primitive was the apparatus of these early fire brigades that it seems a wonder to us now that they could accomplish anything at all against even a single house afire. Everybody has seen the old prints depicting fire scenes of that period; the eight or ten men working the old hand-pump; one or two men squirting a stream of water on the flames from a hose not much thicker than an ordinary garden hose; and the two chains of firemen formed between the pump and the nearest source of water supply, passing the buckets to and fro.

The invention of the steam engine brought about a big change. In one way it was for the better, for with steam-driven machinery big pumps could be employed, capable of throwing powerful streams of water against burning buildings. The first steam fire pump was used in England, in 1829. Its first appearance was ridiculed and the name "steam squirt" was laughingly applied to it. Even so was the first steamship laughed at. Yet the "steam squirt" was the first of the modern apparatus used to-day by our fire companies, so complicated that whole books are written on how to work them.

INCREASING DANGER FROM FIRES

But so far as the danger from fire is concerned, the invention of steam has not been an unmixed blessing. First of all it brought about our present industrial system; railroad locomotives, showering sparks on shingled roofs, factories and warehouses full of inflammable goods, cheap lumber, which encouraged more than ever the building of wooden houses. Then too followed the invention of matches, one of the most common origins of fire outbreaks, and the use of petroleum for lighting. Meanwhile, too, smoking was becoming a common habit among men.

In Europe these innovations did not increase the danger to the same extent as in this country, for there the houses were largely built of stone and brick, because of the growing scarcity of timber. But in this country the risks multiplied tenfold. The white and yellow pine, which was the principal material used in the building of American houses, was especially inflammable. Americans, with their characteristic love of personal liberty, would not tolerate building regulations.

What right had the city to tell a free-born citizen how he should build his home? And if John Smith & Co. chose to erect a wooden warehouse in which to store cotton or cases of petroleum, whose business was it but their own? If they were willing, for the sake of saving extra expense, to run the risk of fire, from which they would suffer most, who had the right to interfere?' It is only of late years that we are beginning to realise, as they did long ago in Europe, that our personal liberties must not endanger the welfare of our neighbours.

GREAT FIRES IN THE UNITED STATES

From the earliest days this has been the country of big fires. New York suffered heavily in 1835 and again in 1856; Pittsburgh was destroyed in 1845; Chicago was almost completely wiped out in 1871 and Boston suffered heavily in 1872. Charleston, Philadelphia, Savannah, Portland and San Francisco, each has a terrible fire history of its own. Where a European city suffered disaster once or twice a century, American cities suffered three or four times in the same period.

With the same energy that they had employed in building up this wonderful country, the Americans set about organising means of protecting their possessions against this terrible and growing danger. The result was that our fire departments have been, from the very first, the best and the most efficient in the world. Need calls forth invention. It was our pressing need of fire-fighting apparatus that caused us to improve on European inventions and to invent machines of our own. Another fire danger peculiar to this country was the tall buildings that were being erected, especially in New York. This called forth the invention of the water tower, an apparatus that would be almost unnecessary in most European cities, where houses are seldom more than three stories high.

THE BEST FIRE DEPARTMENT IN THE WORLD

No wonder, then, that New York, with its skyscrapers, should have the biggest and best fire department in America. While buildings were limited to three or four, or even five, stories, it was comparatively easy to deal with outbreaks of fire. But when they began shooting fifteen, twenty and even forty stories into the air, a new problem presented itself to the city fire officials. At first there was some talk of passing laws against the erection of such high buildings, but finally the engineers who were specialists in this line found a solution to the difficulty; the high pressure system.

They conceived the idea of building permanent pump houses in which could be installed gigantic steam pumps, so powerful that they could throw streams of water from the nozzles of hoses with almost the same force that a shell is fired from the mouth of a cannon. These pumps would be connected with the entire water piping system throughout the section of the city in which the skyscrapers were situated.

THE HIGH PRESSURE SYSTEM

When the first test of the high pressure system was made each pump station, five in number, made a delivery of 18,000 gallons of water a minute. Some of the individual pumps discharged as much as 3,800 gallons a minute. So powerful is a stream of water from a high pressure hose that, when directed at the side of a building on the level of the street, it can make a brick wall crumble as though struck by an explosive shell. By raising the stream at an angle of eighty degrees it could easily reach the cornice of the highest apartment house in the city, or it could wash the dome of St. Paul's Cathedral in London.

Naturally such advanced methods of fire fighting demand expert handling. However enthusiastic they might be, volunteers would not be competent for such a task. So not only are the chiefs men who give all their time, sometimes all their lives, to this profession, but the men are picked and trained even more carefully than are the men of the army and navy.

HOW FIREMEN ARE CHOSEN

First of all, the applicant for the position of common fireman must pass a very strict physical examination. His body must be strong and as near perfect as possible; even catarrh or ingrowing nails are sufficient cause to disqualify him. After he has been passed by the doctor he must undergo the test for muscular strength. The candidate must hang suspended from the rung of a horizontal ladder by his hands, then pull himself up till his chin is above the rung; he must perform this feat fourteen times, enough to tax the strength of a trained athlete. Next a dynamometer is used to test the strength of the leg and back muscles and the joints of the knees. Finally there are various jumping feats to perform.

After passing all these examinations successfully the candidate must await his turn for appointment. When that time comes he is assigned to active duty on probation in one of the hardest districts of the city, where he will have plenty of opportunity to show his mettle. If he is a coward it will soon be found out.

HOW FIREMEN ARE TRAINED

But first he must attend the college training school for probationers; like the soldier he must undergo a period of drill before he is sent out on the firing line. Here he is trained in the use of scaling ladders on a building a hundred feet high.

At the school the recruit is assigned to one of the drill squads and gradually broken in. He is taught to handle, raise and balance the ladders before he is allowed to use them. As the ladders weigh from twenty to sixty-five pounds and range from fourteen to twenty feet in length, it can be seen that it takes experience to handle them. After the novice has mastered this he is made to climb to the first window, then to the second and, as his nervousness gradually leaves him, he mounts to the top.

Next the young fireman is taught how to build a "chain," a series of ladders hanging from the windows, up to the top, a man being stationed at each window. In this drill when the first man reaches the first window he fastens himself to his ladder by means of a large steel snap, attached to a strong canvas belt about his waist. Then he reaches down and pulls up another ladder, passed to him by the man below. At the top of each ladder is a long hook which just fits over the sill of a window. This the first man raises and hooks into the window above him, after which he climbs it, swinging like a monkey on the bough of a tree. And so the chain is built, each man coming up from below carrying one ladder for the chain. This exercise is well adapted to test the nerve so necessary for braving the dangers to which all firemen are exposed at some time or other.

There is, indeed, need for iron nerve, for it is no human enemy that this fire army of New York must fight. The dangers to which firemen are almost daily exposed may not seem so picturesque as those which soldiers must undergo on the firing line, but, considering the smaller numbers engaged, the killed and wounded are quite as many. Only too often does a company return to the firehouse after a fire with one or more of its members missing. If the missing have not been carried to the hospital they are dead, for the battle has been with an enemy that never takes prisoners.

WHAT FIRES ARE MOST DANGEROUS

It is not always the fire that goes roaring through the roof of a building, lighting up the streets for a mile around, that presents the most danger. It is in the dull, smoky cellar fires that the fireman is most often overcome by smoke or gas. Then there is the awful "back draft," which every fireman soon learns to dread. Dashing up the stairway of a burning building, dragging the hose after them, the men come to a closed doorway. With axes they smash in the door. The smouldering fire within is exposed to view — and to the inrush of fresh air. For a moment there is an awful pause; then, as the oxygen strikes the fire the whole room explodes into a roaring flame. Out through the open doorway leap the fiery tongues, as though flashed from the mouth of a cannon. The experienced fireman instinctively falls flat, his face in his hands, ducking the blow. But many a man has been killed or horribly burned by back draft. At one fire, in New York City, some years ago, this kind of an explosion blew out the whole front of a building and severely injured the greater part of a whole fire company.

The falling wall is another common danger. Sometimes a brick wall will fall down straight, buckle in the middle and crumple, dropping like a curtain. The tumbling bricks are then easily dodged. But quite often the whole wall will fall straight out, reaching clear across the street and remain almost solid until it strikes the ground. This is the kind that kills or cripples whole companies.

Broken glass and molten lead are other perils met with at almost every fire. All through the department are found men bearing scars from wounds inflicted by glass splinters. And again they will enter large buildings not yet in full flame, encounter thick smoke and lose the way out. In such a case the experienced fireman immediately drops down beside his hose and, by following it, reaches the entrance.

THE NAVAL FIRE FIGHTERS

We have likened the five thousand men of the New York Fire Department to an army, but there is a section of it which should rather be compared to the navy. In New York, as in all cities on the water, there are certain sections which cannot be easily covered by the fire fighters on land, or at least, they can only attack fires there from one side. That is the shipping district; the docks reaching out into the river or the bay, on some of which are big warehouses filled with combustible goods, and especially the ships moored alongside. On catching fire a ship is likely to have its mooring lines burned through and then drift out, out of reach of the streams from the fire hose. What adds to the danger of water-front fires is the fact that a fresh breeze is nearly always blowing in from the water, ready to fan the flames inward. And a fire can be fought most effectively from the windward side.

To protect its long line of shipping New York maintains a fleet of fire boats, really floating fire engines. At first glance one of these fire boats might well be taken for a torpedo boat, for the rows of brass-headed hose connections along the side of the deckhouse and the formidable-looking stand-pipes, or "monitor nozzles," as they are called, mounted fore and aft, give the appearance of naval armament.

THE FIRE BOATS OF NEW YORK

Each of these marine fire fighters is moored at a dock, beside a house erected by the Fire Department especially for her crew. This building is fitted up very much like any fire house; sleeping quarters upstairs, sliding-poles by which the men can descend quickly to the ground floor, and a full set of telegraphic instruments by which the company may be informed of all the alarms that are sounded throughout the city. The boat itself lies with steam up, at all times ready to speed away on business, whether it be to a burning ship or lighter in mid-stream or to a burning coal bunker or dock at the other end of the city.

These boats are built of steel throughout and the deckhouse and wheelhouse is made of cement; there must be no woodwork about them that could ignite, for sometimes they are obliged to approach very close to a fire and deliver their streams at close quarters.

One of these fire boats, the *New Yorker*, can throw 12,000 gallons of water a minute at a blazing dock. The water, of course, is pumped up from over the side, up into an air chamber, which equalises the pressure, then into a twelve inch pipe which runs all around the boat, just below the deck, from which there are forty-two outlets for hose connections, the biggest being six inches in diameter. Some of these lead to mounted nozzles, resembling machine guns, two of which are on top of the wheelhouse. From one of the latter a stream of water can be thrown over three hundred feet.

With all her power going the *New Yorker* can bombard a burning ship or warehouse with a veritable cascade, which only the biggest blazes can withstand for long. One blow from her monitor nozzle stream can make a hole in a brick wall.

Almost laughable is the fact that each of these boats, in spite of its being built especially for going into the very midst of the flames, must carry a row of fire buckets in its wheelhouse. Such is the regulation applying to all boats plying New York Harbour. Since laws must be applied to all alike, no exception can be made in favour of the fire boats.

A TERRIBLE WATER-FRONT FIRE

Many have been the terrible sea battles with fire through which the New York fire fleet has rendered splendid service. Perhaps the most brilliant service it has rendered, when its efficiency was taxed to the utmost, was its battle with the flames during the disaster that occurred in 1900. A fire started on one of the piers on the New Jersey side of the river, alongside of which the big German passenger liner *Saale* was moored. In less than fifteen minutes the flames, fed by stores of cotton, turpentine and oil, swept from pier to pier. A strong breeze was blowing at the time. Before anybody could realise the immensity of the outbreak a quarter of a mile of docks and ships was ablaze.

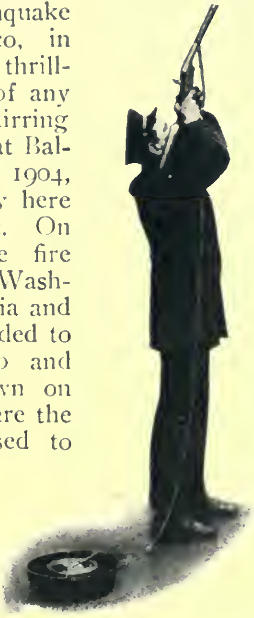
The *Saale* and four other big German passenger ships were crowded with visitors. Before the crowds aboard could realise what was happening they were in the midst of a roaring vortex of flames.

Whether they were cast loose by their crews or whether their mooring lines were burned through, the four big steamers, each blazing like a torch, drifted out into the river, crowded with people. Hundreds jumped into the water and of them some were rescued by tugboats and other craft, but most of them were forced down below into the holds. The portholes were too small to permit of their escape, and there most of them perished. Altogether over four hundred people, mostly women and children, were burned to death.

HOW THE FIRE BOATS SAVED NEW YORK

But it was the fire fleet which saved these drifting conflagrations from setting ablaze the whole length of the shipping district on the New York side. One of the burning steamers, the *Bremen*, drifted across the river and set fire to a wharf, then to a lighter. One after the other the fire boats quenched these blazes. Finally they were able to give their whole attention to the four great steamers blazing in the river, and grappled with them at close quarters, pouring whole broadsides of water into them. Had it not been for the effective service they rendered on this occasion there can be no doubt that one of the biggest conflagrations in the history of any seaport would have swept the New Jersey and New York shores of the Hudson River.

Whole books might be devoted to the exciting encounters of the American fire departments with the enemy. The heroic fight of the firemen with the great fire that followed the earthquake in San Francisco, in 1906, is quite as thrilling as the story of any war. Another stirring event was the great Baltimore fire, in 1904, though fortunately here no lives were lost. On this occasion the fire companies from Washington, Philadelphia and New York responded to the call for help and were hurried down on special trains. Here the flames had opposed to them the forces of four big cities as well as the minor reinforcements that were sent from small neighbouring communities.



The rope gun carries a string with it by which a rope may be hauled up to those whose escape has been cut off by flames.

WHY SUCH FIRE DEPARTMENTS ARE NECESSARY

At first thought it might seem that we have reason to boast of our superior fire departments, and, indeed, we really have reason to be proud of the brilliant fights that our firemen have made. But on closer examination, on comparing the way we handle fires with the way the Europeans handle their fire problem, it might seem that we have very little to be proud of.

Why is it that in this country fire destroys four times as much property as in England? Our yearly loss amounts to about three hundred million dollars; about three dollars for each man, woman and child of the population. The average for European cities is much less than a dollar for each person.

The answer is that in Europe they apply the old proverb that an ounce of prevention is worth a pound of cure. First of all, European cities have passed very strict regulations in the building of their houses, especially in limiting their sizes. There the people recognise the right of the city to dictate to its citizens of what material they shall build houses or factories. We, too, have begun to learn this lesson.

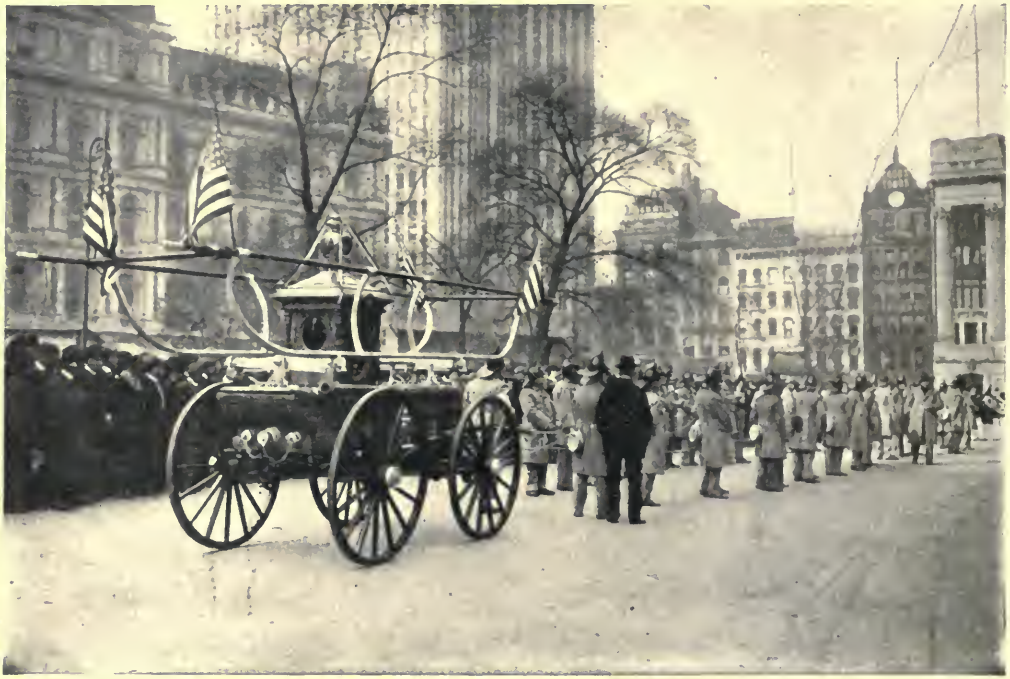
FEWER FIRES IN EUROPE

Another reason why the cities of Europe suffer less is because they were not above taking example from ancient Rome; with them the office of "questionarius" plays an important part. Probably most of our fires are caused by carelessness. The Europeans will not tolerate this as an excuse. They regard carelessness which endangers the lives and property of the city as a crime and punish it accordingly. One of the fire chiefs of New York gives an illustration in an incident which occurred while he was on a visit to a German city.

A blaze broke out in a small, private hotel at which he was stopping. The fire department responded to the alarm, put out the blaze, which did little damage, then carefully cleaned up the mess they had made. Next the fire marshal summoned the guest in whose room the fire had occurred. He was able to prove that it had happened through no fault of his. A coal had dropped out from a stove and ignited the floor. Next the landlady was sent for. She stated that she had just bought the house and that the stove stood as it did when she took possession. Then the previous owner was directed to appear before the fire marshal. He admitted that he had neglected to comply with the laws demanding that the floors be protected by metal sheeting. Thereupon he was heavily fined.

We, too, are adopting this method of prevention. Many American cities now have appointed fire marshals, whose business it is to "ask questions." We are indeed learning that prevention, rather than heroic fire-fighting, is the solution of our fire problem.

SURVIVALS OF EARLIER DAYS IN FIRE FIGHTING



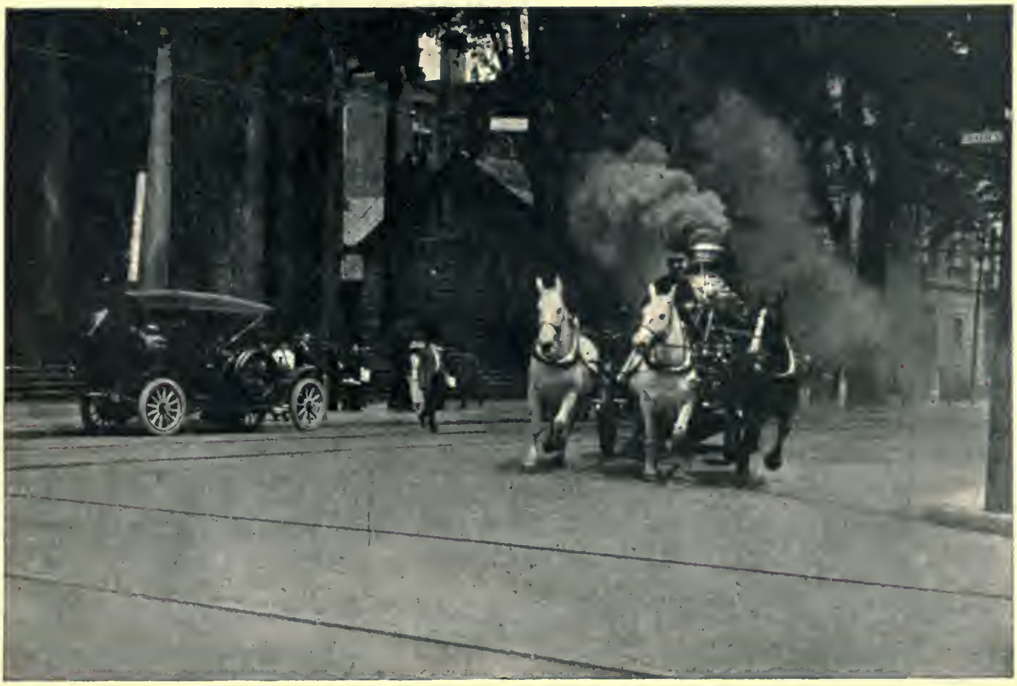
AN OLD HAND ENGINE PRESERVED AS A CURIOSITY

Steam fire engines supplanted the old hand engines just as motor engines are supplanting steam. Here is shown one of the old hand engines, which was drawn by the firemen themselves, generally volunteers. The water was pumped by raising and lowering the bars at the side, which we here see lifted out of the way.

SPECIMENS OF DIFFERENT STAGES IN FIRE FIGHTING

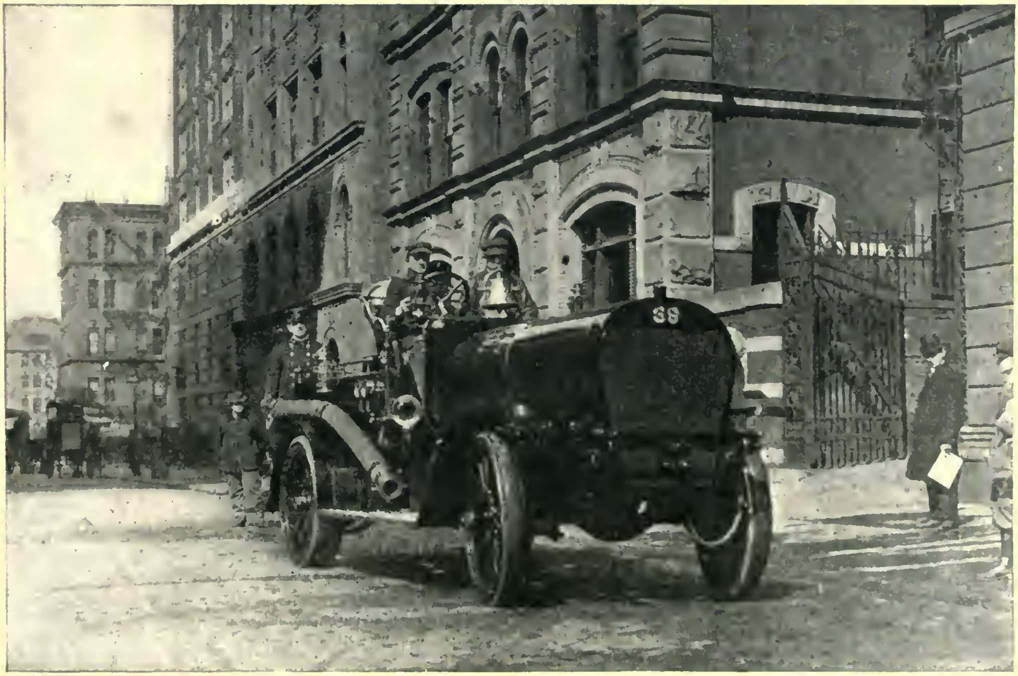
Several years ago, the New York Fire Department showed in a parade the different kinds of fire fighting apparatus which had been used in New York from early times. Here a part of the parade is shown about to start. The signs describe the apparatus and tell when it was used, or else give advice on fire prevention.

THE PRESENT AND THE FUTURE IN FIRE ENGINES



THE GALLOPING HORSES ON THE CITY STREETS

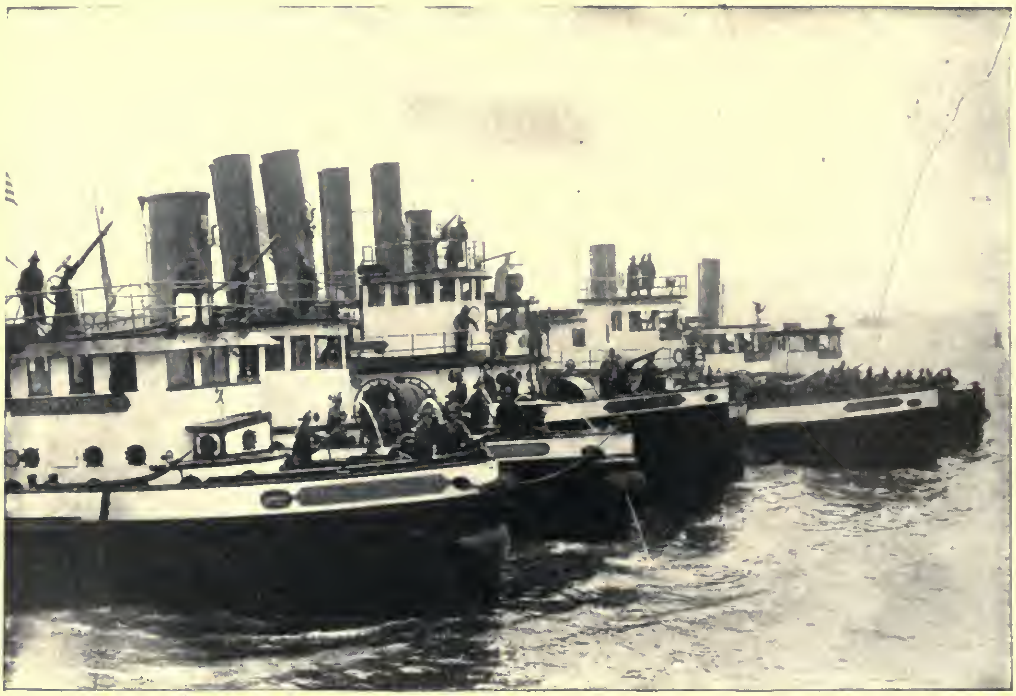
No sight is more thrilling than to see a fire engine on a city street. The galloping horses, with sparks flying from their feet, the clanging bell, the whistle, all unite to make an impression which is never forgotten. In many cities horse-drawn engines are being supplanted by motor-driven engines, like those shown below.



THE QUIETER MOTOR ENGINE GLIDES ALONG

The newest fire engines are powerful motor-driven vehicles. When the fire is reached, the same engine pumps the water. Though these engines reach the fire much more quickly and pump more water than the horse-drawn steam engines, many are sorry to see the horses go. The new is less picturesque than the old.

GUARDIANS OF THE SHIPPING IN THE HARBOUR

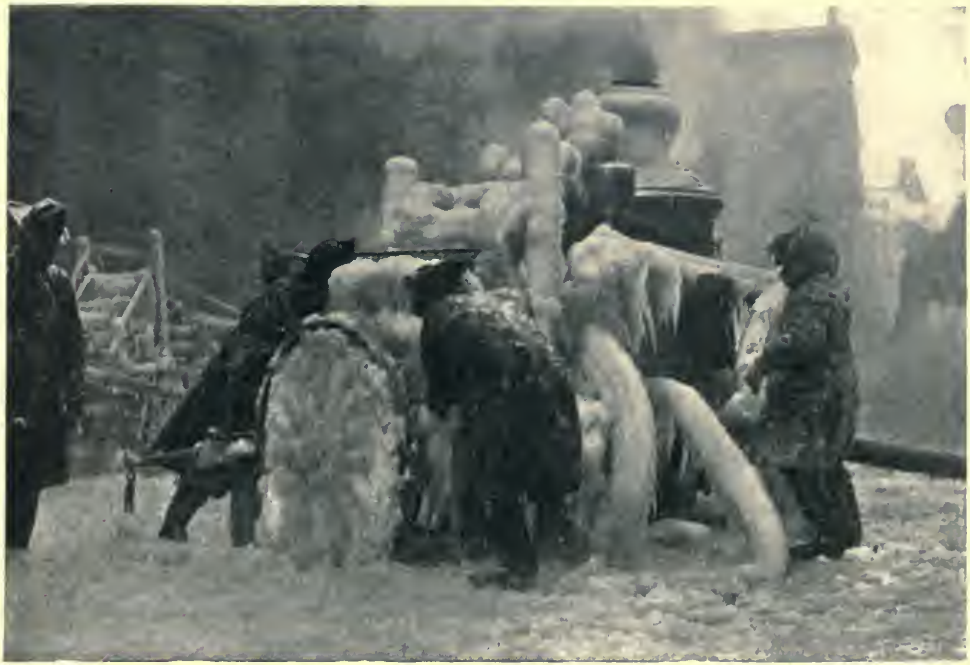


Some of the piers in New York Harbour are a fifth of a mile long, and a fire near the end, or on a ship lying beside the pier, cannot be fought to advantage from the shore. These fire boats are swift, and since they have an unlimited supply of water can drown out any ordinary fire. Each has several nozzles on both decks, with which they can throw powerful streams into the heart of the fire.

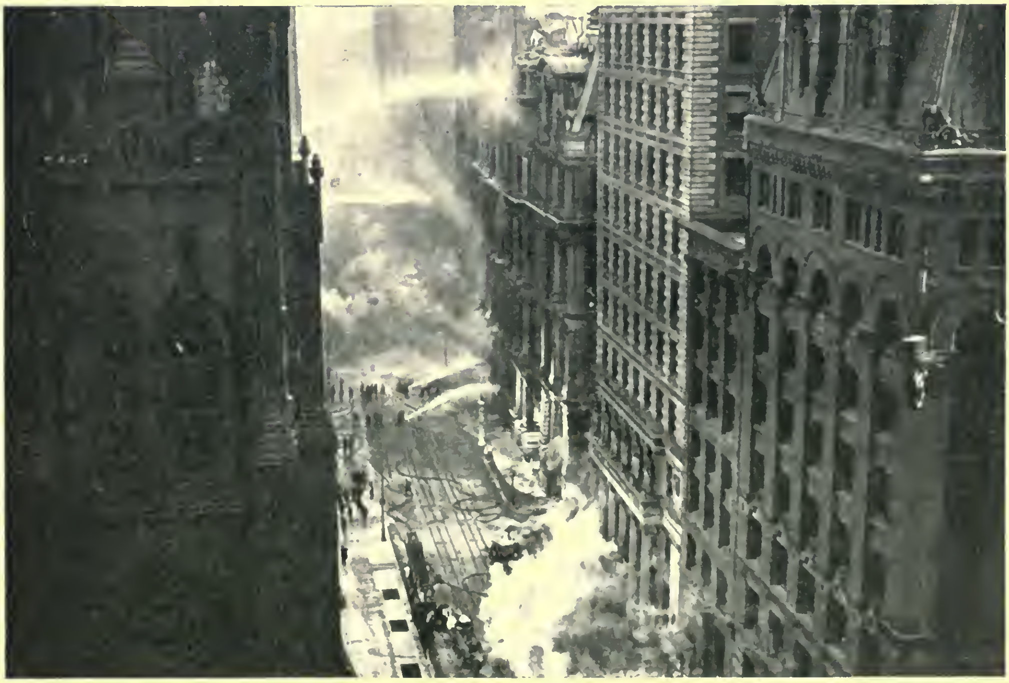
FIGHTING FIRE FROM THE TOP OF A BUILDING

Firemen attack a fire from every point. Some drag hose into the building if possible; others direct the water tower or send streams from the ground or an adjoining building. Here we see two firemen holding with difficulty the nozzle of a hose, which has been carried to the top of an adjoining building.

FIGHTING A BAD FIRE IN ZERO WEATHER

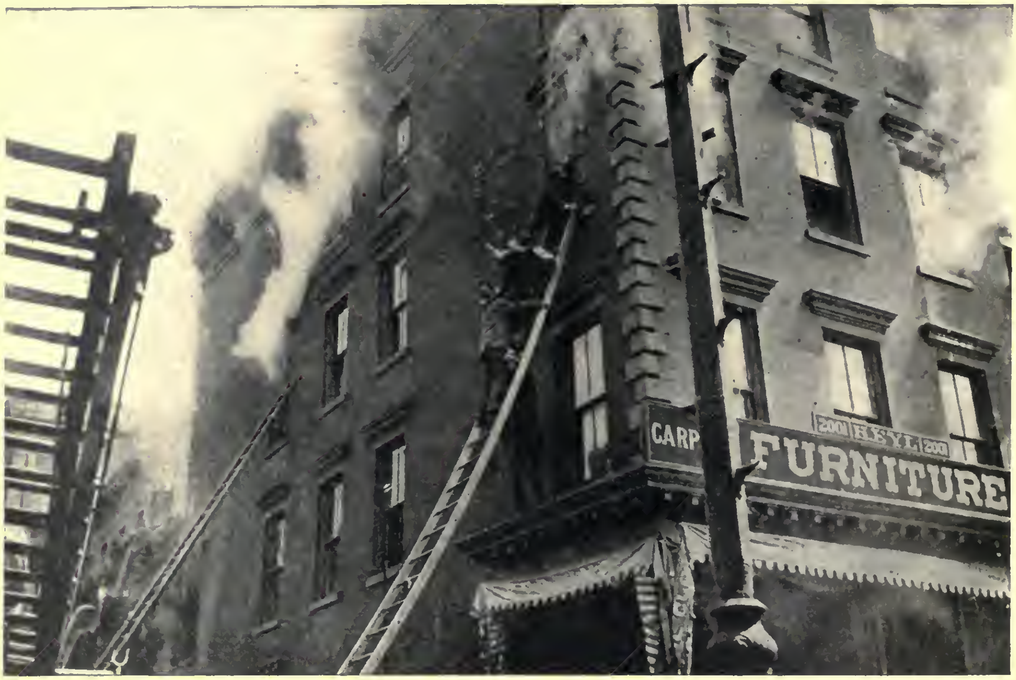


In cold weather when the wind is blowing, the spray may freeze as it falls, and add greatly both to the discomfort of the firemen, and to the difficulty of the task. Here we see that both engine and firemen are covered with ice. One moment the hardy firemen may be exposed to excessive heat and the next to terrible cold, which chills them to the bone. Such discomfort is accepted as a matter of course.



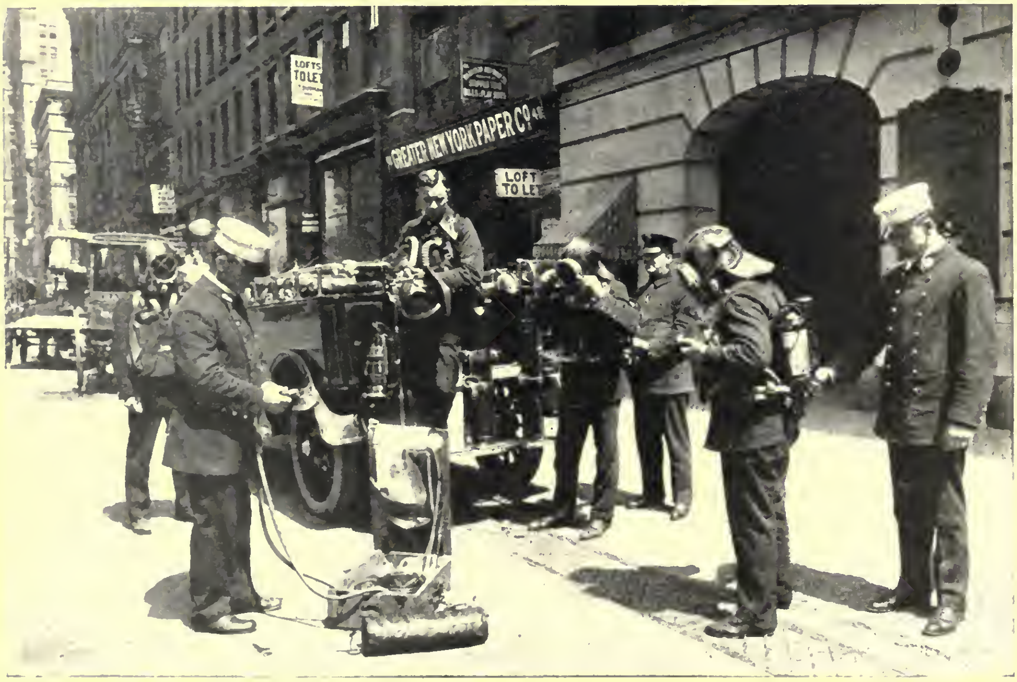
One of the most destructive fires in recent years caused the destruction of the Equitable Building in New York City in January, 1912. The fire was discovered during the night, and therefore the loss of life was very small. In spite of all the efforts of the fire department, the property loss was enormous. Traffic was suspended on Broadway for several days, and trains were stopped in the subway, which here runs under the street. The building itself was so badly damaged that it was necessary later to tear it down.

SAVING LIFE A PART OF THE FIREMAN'S DUTY



AN EASY BUT THRILLING RESCUE

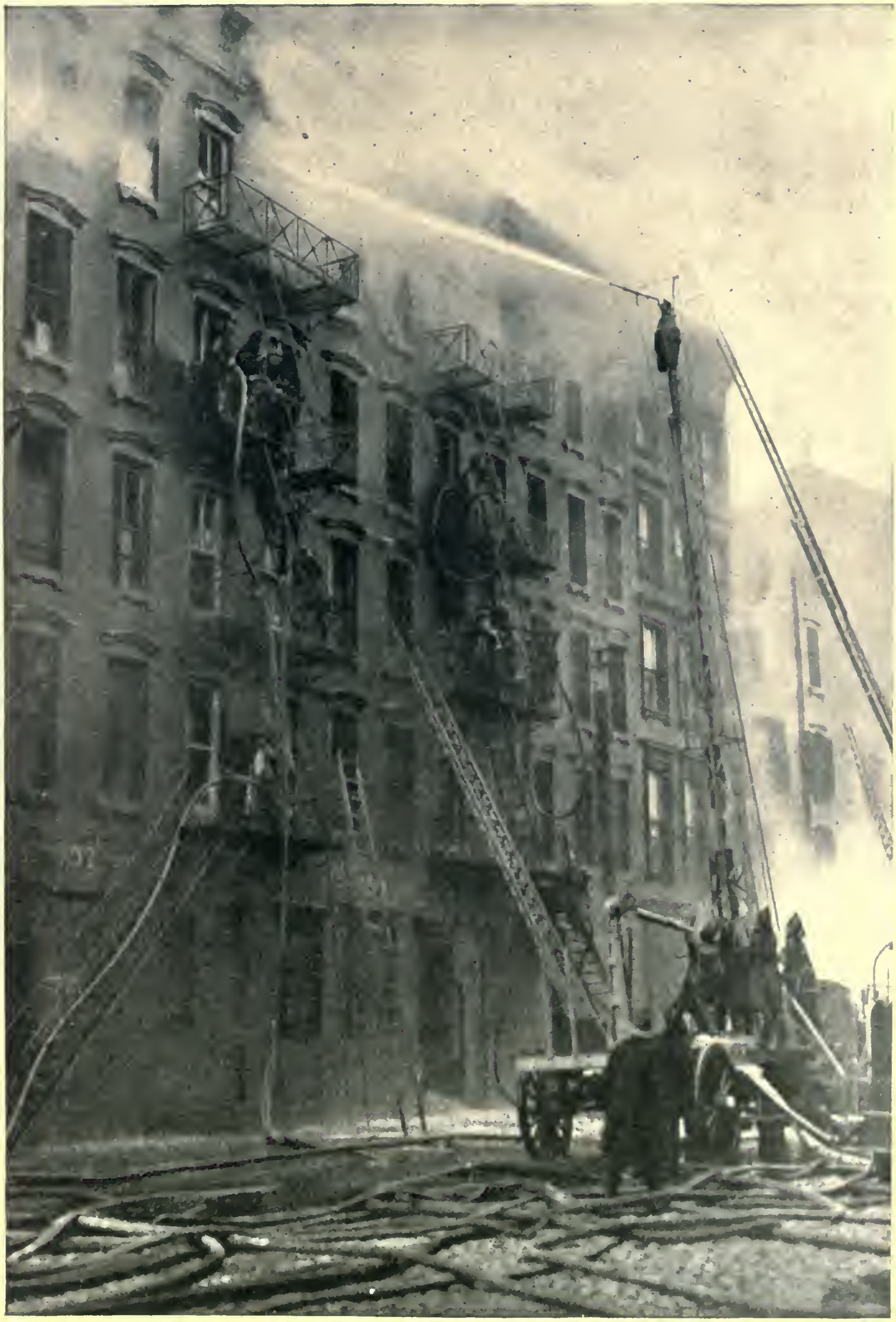
Such a scene as this is in the day's work of a fireman. If the stairway is blocked a ladder is run up to a window, firemen clamber up and bring out any who are helpless from age or sickness or who have been overcome by smoke. We see them here bringing down someone from the third story.


LOFTS TO LET
GREATER NEW YORK PAPER Co
LOFT TO LET

THE RESCUE SQUAD OF THE NEW YORK DEPARTMENT

This is one of the latest developments in rescue work. The men you see have on helmets which cover their heads and faces entirely. On their backs are cylinders which generate oxygen, and purify the air which the men breathe out. Thus equipped they can go into a building, even though it be filled with the thickest smoke, or even with poisonous fumes, without suffering any harm.

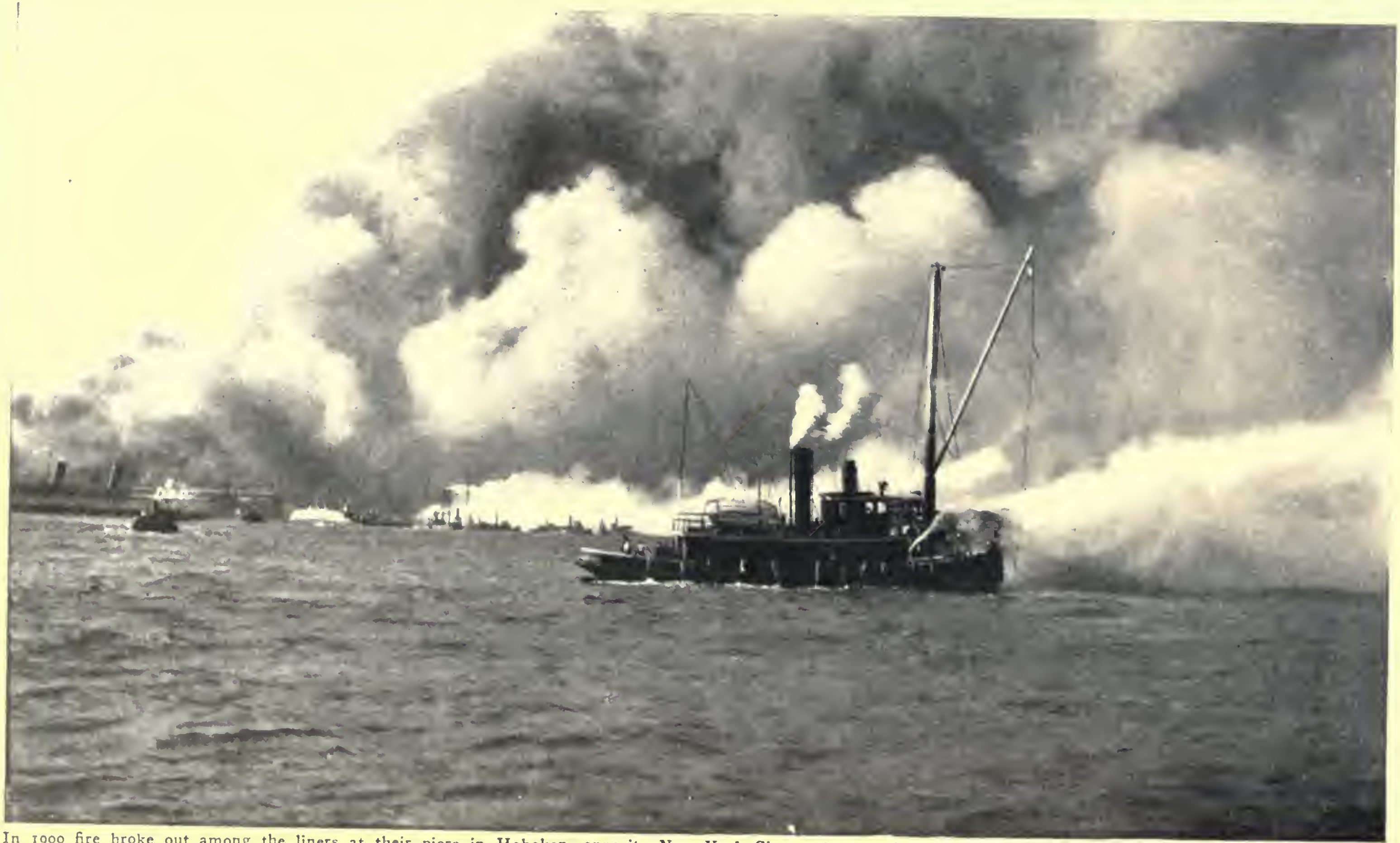
A WATER TOWER IN ACTION



The water tower is a valuable aid in fighting fire. While going to the fire, it lies flat on the truck. When the fire is reached, it is raised and extended to the desired height. It can then send the water directly on the fire even if it is far back in the building. Another nozzle is on the truck. Here we see firemen carrying hose into the building from many engines and hydrants which are not shown in the picture.

Photograph by Underwood and Underwood.

FIREBOATS SAVING THE CITY IN THE GREAT HOBOKEN FIRE



In 1900 fire broke out among the liners at their piers in Hoboken, opposite New York City, and raged fiercely. The cables which held the ships were burned, and the great vessels swung out into the stream. One drifted across to the New York side and the piers there caught. But for the wonderful work of the fireboats, it is probable that both cities would have been swept by a disastrous conflagration. In spite of all efforts, many persons in the ships lost their lives.

The bell that rings in good news on the Mount of Olives—taking the bell up the Mount

THE SWINGING, RINGING BELLS

THE GLAD NEWS & SAD NEWS THEIR MELODY FORETELLS

It has been said that a city without bells is like a country without singing birds, and certainly it is as difficult to imagine the one as the other. That must indeed be a sad land in which there live no birds to herald the coming day and to make the sunny hours glad with the music of heaven; and a city with no bells to chime the hours, to call to prayer, and to sound out joy and gladness, must be like a city of the dead.

All the great and solemn occasions of life, all the grand events of national history, all the seasons of joy and sorrow, have for ages been marked by the merry ringing or the solemn tolling of the bells, and it is doubtful if any other form of music has so moved the hearts of men.

Over and over again the poets have been stirred to song by the music of the bells; and as Tennyson tells us of the ringing in of a new year, we can almost hear the voice of the bells speaking to us with their "iron tongues and brazen mouths." Edgar Allan Poe, too, in his famous poem, leads us from the happy tinkle, tinkle of the sledge-bells and "the world of merriment their melody foretells" to the loud alarum-bells, brazen bells. "How they clang and clash and roar," as we read the verses, and at the end it seems as if the din of the bells were still in our ears. Bells, in the sense of the large melodious instruments that hang in our church steeples, are practically a Christian institution, for in Europe, before the birth of Jesus, there were no such bells; and, although in the East large bells probably existed thousands of years ago, their sound was harsh rather than melodious, for instead of being cast in one piece they were built up of metal plates riveted together.

It is in the last thousand years that the making, and tuning, and ringing of bells has been brought to perfection; and during that time the bells may be said to have influenced the lives and histories of the nations. Something of our architecture we owe to the bells, for it was in order to provide a worthy home for them that the beautiful towers and steeples of our Gothic churches and cathedrals were designed and built in days gone by. And even now, although we may not regard the bells with the superstition and reverence of long ago, we still build handsome towers in which to hang our chimes.

It was the bells that summoned the citizens to arms in times of danger, and it was the bells that rang out the triumphant song when victory attended the arms of the people. All the bells of the city would ring out together on a great occasion, and Victor Hugo gives us a vivid picture of the pealing of the bells of old

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Paris, which he calls the singing of the city.

"Lend your ear to this opera of steeples. Diffuse over the whole the buzzing of half a million of human beings, the eternal murmur of the river, the infinite piping of the wind, the grave and distant quartette of the four forests, placed like immense organs on the four hills of the horizon. Soften down, as with a demi-tint, all that is too shrill and too harsh in the central mass of sound, and say if you know anything in the world more rich, more gladdening, more dazzling than that tumult of bells—than that furnace of music, than those ten thousand brazen tones, breathed all at once from flutes of stone three hundred feet high."

And what dark tragedies the bells have heralded! It was at the ringing of the vesper bell on Easter Tuesday, 1282, that the massacre of Frenchmen in the island of Sicily began, which did not cease until every Frenchman had been driven from the island, and the tragedy has ever since been known in history as the Sicilian Vespers.

WHEN THE BELLS TOLD THE PEOPLE THE TIME OF DAY IN MERRY ENGLAND

On the morning of St. Bartholomew's Day, August 24, 1572, the ringing of the bells, which had for centuries called men to prayer, was the signal for the terrible massacre of Huguenots that robbed France of her best blood, and made the name of St. Bartholomew a byword among the nations.

There have always been those who could hear the bells speaking to them, and not merely ringing; and we know from our nursery stories how Dick Whittington, the poor starving boy who had run away from the house where he was ill-treated, sat on a milestone by the roadside, and heard the bells of Bow Church, in Cheapside, sing out the message: "Turn again, Whittington; thrice Lord Mayor of London."

At one time town and village bells were an absolute necessity. Before clocks and watches became familiar objects of everyday life as they are now, the bells told the people the time of day. They rang early in the morning to call men to work, they rang at midday for dinner, and they rang in the evening to say that work was now to end. The bells were rung as a signal for buying and selling to begin in the market, and we all know how the curfew told the people to put out their fires and lights, and to go to bed.

Bells are made of a mixture of metals, consisting of four parts of copper to one of tin. It was at one time thought that a proportion of silver added to the sweetness of the tone, and the old monks used to invite the wealthy to give silver for the making of the church bells. Many old bells, supposed to contain considerable quantities of silver, have been recast in modern times, and their metal analysed, but very little silver has been found. It is thought that while encouraging their supporters to bring silver for the making of bells, and encouraging the belief that this improved the tone, the monks secretly used the silver for other purposes, and substituted tin.

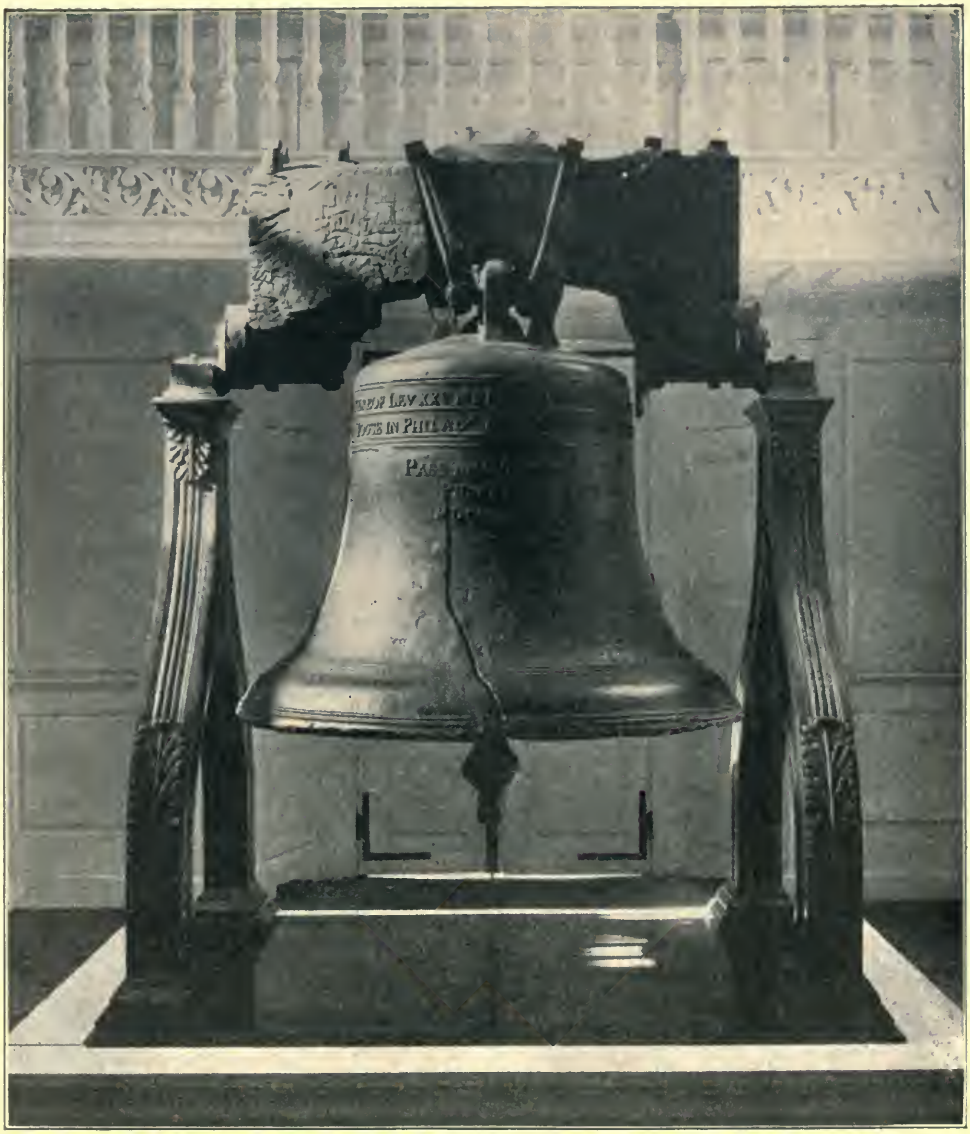
THE GREAT BELL OF MOSCOW WHICH HAS NEVER BEEN RUNG

Some bells are of enormous size and weight, but these are not swung in ringing: the hammer is moved, and strikes the bell, either inside or out. The great bell of Moscow, cast in 1733, was left in the earth where it was moulded for 103 years before being raised. It has never been hung, having been cracked in casting, and it now stands on a platform in an open square of the city, and is fitted up inside as a church. It weighs nearly 200 tons, and the piece that was broken out weighs eleven tons.

Another great bell at Moscow, which weighs 128 tons, is the largest bell in actual use in the world. The biggest bell in England is Great Paul, in St. Paul's Cathedral, London, which was cast in 1881, at a cost of $15,000, and weighs seventeen tons. The largest English bell to be swung is the tenor bell at Exeter Cathedral, which weighs just over three and a half tons. Of course, the swinging of a massive bell causes great vibration in a tower, and from time to time serious accidents have happened. In 1810 the spire of a church at Liverpool fell while the bells were being rung for morning service, and twenty-three people were killed.

ALL HISTORY IS TOO SHORT TO RING ALL THE CHANGES IN ONE BELL-TOWER

Change-ringing—that is, the ringing of a number of bells in varying orders—is a distinctively English institution, and is practised all over the country. The variations in ringing a number of bells is enormous. Twelve bells can be rung in 479,001,600 different orders, and to ring them all at the rate of two strokes a second would take ninety-one years; while to ring all the possible changes upon twenty-four bells would occupy, at the same rate, more than 117 billions of years. That is to say, there has not been time enough since the beginning of the world to ring all the changes that are possible in one bell-tower. Among bell-ringers 5,000 changes is a complete peal.



LIBERTY BELL

THE LIBERTY BELL

In Independence Hall, Philadelphia, stands the Liberty Bell, which rang forth a joyous peal, July 4, 1776, announcing the adoption of the Declaration of Independence by the United States of America. This peal was also the knell of British domination in the American colonies. The bell had been brought from London in 1752 by the Provincial Assembly of Pennsylvania. It bears the portentous text from Scripture, "Proclaim liberty throughout all the land unto all the inhabitants thereof." Although it had rung joyously on many important occasions it was not until the birthday of the nation that it fully executed this command. When the British approached Philadelphia in 1777, the bell was taken down and carried to Bethlehem for safe keeping. After the evacuation of Philadelphia it was brought back to its former home and rang from Independence Hall for more than half a century. Then an accident befell it. On July 8, 1835, while it was being tolled for Chief Justice Marshall, it suddenly cracked. Since then it has been silent. It was taken down from the scaffolding and lowered to the first floor, where it was hung from its original beam and placed in an ornamental frame in the main corridor.

But though the music of its voice is gone, it is not dumb. Thousands of people make pilgrimages to see it, and to them its silence gives the message that it flung to the winds in joyous tones so many years ago. We cherish it as a symbol of the liberty that our forefathers fought to gain and that, if need be, we will fight to keep.

People throughout the country desire so much to see the bell that it has been lent to some of the great exhibitions so that the throngs of visitors might look at it. It has gone to Chicago in the North, as far South as New Orleans, Louisiana, and to San Francisco in the West, carrying its message of "liberty throughout all the land." Its last journey was taken to the exhibition at San Francisco, held in 1915 to mark the opening of the Panama Canal. When it left Philadelphia, speeches were made, children sang patriotic songs, it was provided with a guard of honour, and the bell in Independence Tower was rung. The railway company built for it a special car, provided, like a passenger coach, with buffers so that it should not be jarred, and with lights arranged to shine on it so that people might see it as it sped through the darkness on its westward way.

Everywhere the children watched to see it. In Chicago thousands of them stood in line, though the rain poured down upon them. But they were rewarded for their patience. For two hours grown up people were shut out. The children had the bell all to themselves, and until the time was up, they pressed forward in continuous procession to see it. It was the same all the way across the thousands of miles between the two cities. In one place, the children waited for it long past midnight, and the little ones were lifted up that they might pat it with their tiny hands. In another, an old Confederate soldier uncovered his head, as he stooped with tears in his eyes to press his lips reverently to the symbol of his country's freedom.

Great preparations were made in San Francisco to receive it, and the day of its coming was a festival. A choir of fifty thousand children lined the way by which it passed, and sang the Star Spangled Banner as it was carried along between their flower laden ranks. The procession was marshalled by a Rear Admiral of the navy, thirteen guns were fired by the fleet in the harbour as it passed the centre of the city, and when it reached its resting place, the roar of a salute was heard again, this time forty-eight guns being fired — a gun for each one of the states in the Union.

COLUMBIAN LIBERTY BELL

At the Fourth of July celebration, at the World's Columbian Exposition, 1893, the Columbian Liberty Bell was rung for the first time. With the Liberty Bell and the Centennial Bell it was the centre of the celebration. The Columbian Liberty Bell is the first bell that was made to ring only on the anniversaries of Liberty Events in the history of the world. The metal of which it was made was contributed by more than 22,000 persons. These contributions were all associated in some way with efforts for liberty, or with the lives of "Creators of Liberty." Over 250,000 pennies were sent in. It bears the scriptural text, "A new commandment I give unto you, that ye love one another."

OLDEST PEAL OF BELLS IN AMERICA

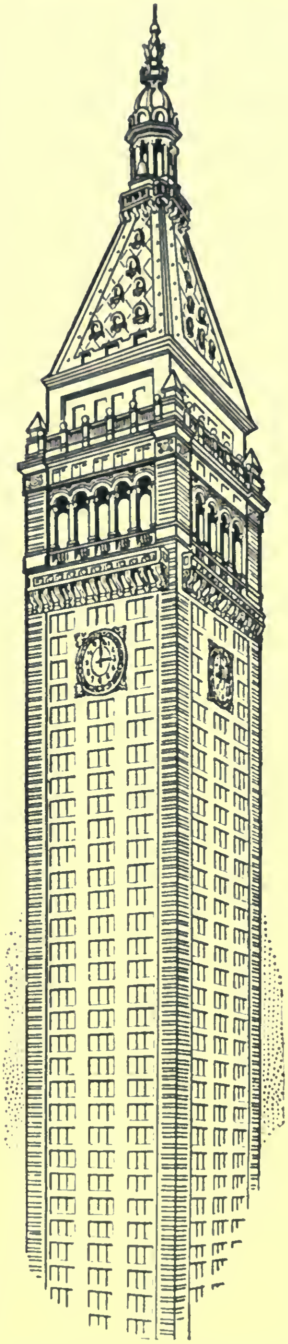
In the tower of Christ Church, Boston, is the first peal of bells brought to America. These eight bells were cast in England and hung in Christ Church steeple in 1745. They cost £560, which was raised by subscription The combined weight is 7,272 pounds, the smallest weighing 620, and the largest 1,545 pounds. Each bell bears an inscription around the crown, telling some interesting facts about the bells or the church. They are still considered the sweetest toned bells in the country. Four or five years after the bells were put in place, a guild of bell ringers was formed. Paul Revere was one of these and it was from the belfry of Christ Church, sometimes called "The Old North Church," that the signal lights were hung which sent him on his famous ride. An inscription on the steeple tablet states that the steeple was restored in the year 1912 by the descendants of Paul Revere.

ST. MICHAEL'S CHIMES, CHARLESTON, SOUTH CAROLINA

The famous chimes of eight bells in St. Michael's Church, Charleston, South Carolina, have had a very adventurous career, for they have crossed the Atlantic five times. They were cast in London and were installed in the steeple of St. Michael's in 1764. When the British evacuated Charleston in the Revolutionary War, they took possession of the bells and carried them to England. A merchant of Charleston bought them and sent them home. When they were unloaded and hung in the belfry there was great rejoicing that the city had got its voice back again. But the bells' adventures had only begun. In 1823 it was discovered that two of them were cracked. After local workmen had made several unsuccessful attempts to restore the tones, the two damaged bells made a second trip to England, this time to be re-cast in their original moulds. In 1839 they were again hung in their place and, to the great joy of the people, rang until the time of civil strife and discord came.

In 1862, during the bombardment of Charleston, St. Michael's chimes were taken down and moved to Columbia, South Carolina, to escape injury, but this was a most disastrous move, for, during the occupation of Columbia by Sherman's army, the bells were burned in the fire of February 17, 1865. They were so loved by the people, however, that the precious fragments were sacredly guarded, and when the war was over, they were sent to London to be re-cast. Strange as it may seem, the original moulds into which they had been poured a century before, had still been preserved. In February, 1867, the eight bells came back once more to their home in the steeple of St. Michael's. The entire set had crossed the Atlantic five times and two of the bells seven times. On March 21, they rang out joyously the tune, "Home Again, Home Again from a Foreign Land." Since then they have passed unharmed through many dangers. In spite of a cyclone and an earthquake that nearly demolished the church, they still swing uninjured high up in the steeple.

At the close of the eighteenth century the church narrowly escaped destruction by fire. It was saved only by the courage of a negro sailor, who climbed to the top of the tower and tore off the blazing shingles. As a reward for his bravery the slave received his liberty, a sum of money and a fishing boat equipped with nets. Mary A. P. Stansbury has given us a vivid picture of this brave act in a poem entitled "How a Slave Saved St. Michael's."

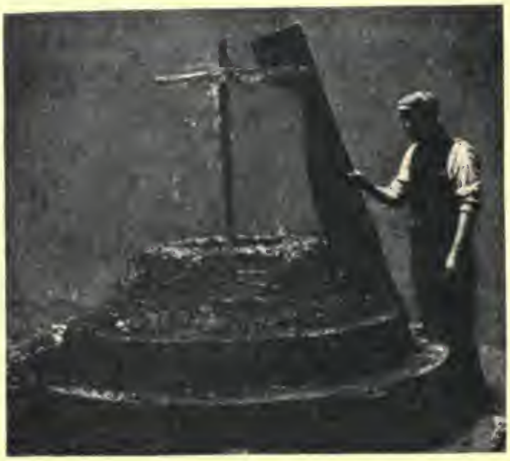


This is the top of the clock-tower of the Metropolitan Life Insurance Company Building. At each quarter hour the bells ring out the notes of Handel's "Cambridge Chimes." Following the fourth or last quarter, the hours are struck on the largest bell, and its sonorous tones can be heard miles away.

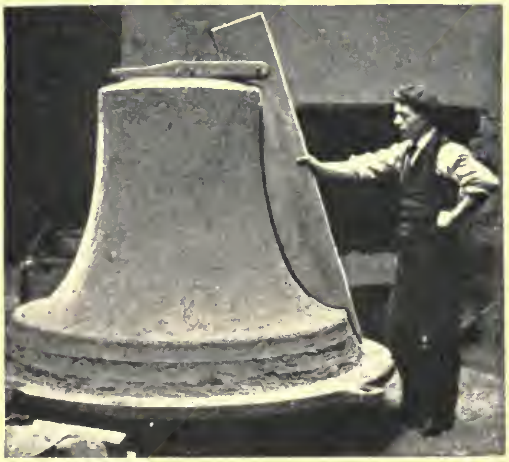
THE HIGHEST PEAL OF BELLS IN THE WORLD

The bells of the tower-clock of the Metropolitan Life Insurance Building, New York City, are said to ring at twice the height of any other large bells in the world. They have a fitting home, for the clock itself is the largest four-dial tower-clock in the world. The four bells weigh seven tons, the largest weighing 7,000 pounds, and the smallest 1,500 pounds. They are mounted on pedestals between the marble columns, outside the forty-sixth story, and are rung automatically by electricity, which is transmitted from the master clock on the second floor.

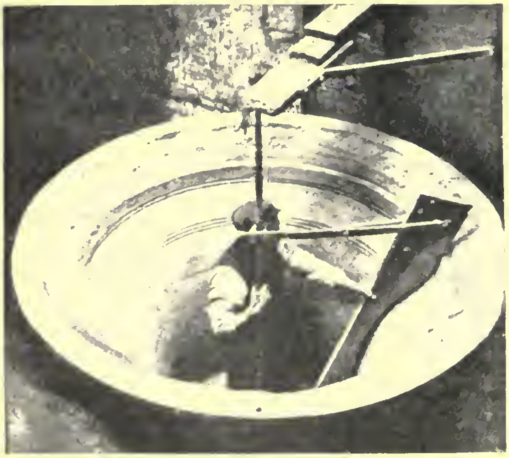
MOULDING THE SHAPE OF A BIG BELL



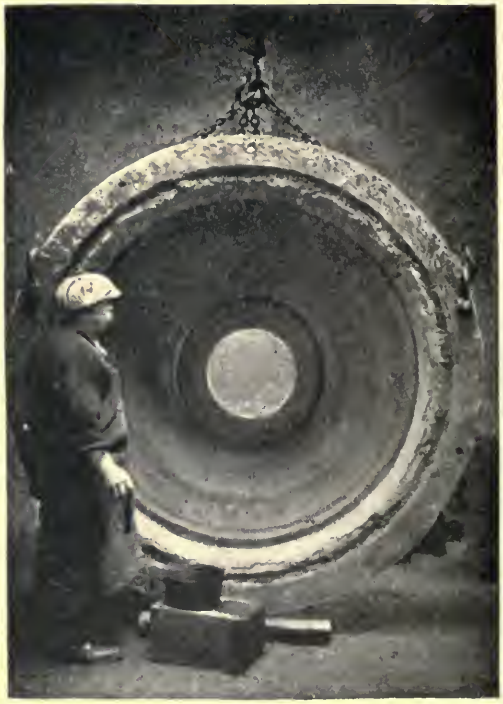
BUILDING UP THE CORE



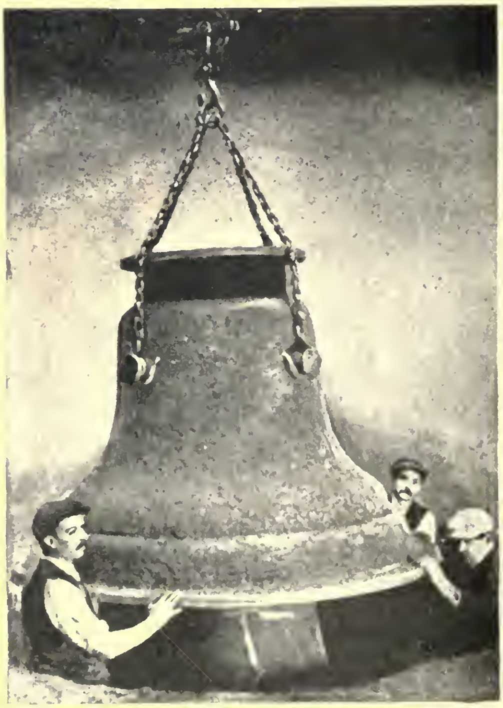
FINISHING THE CORE



SHAPING THE MOULD



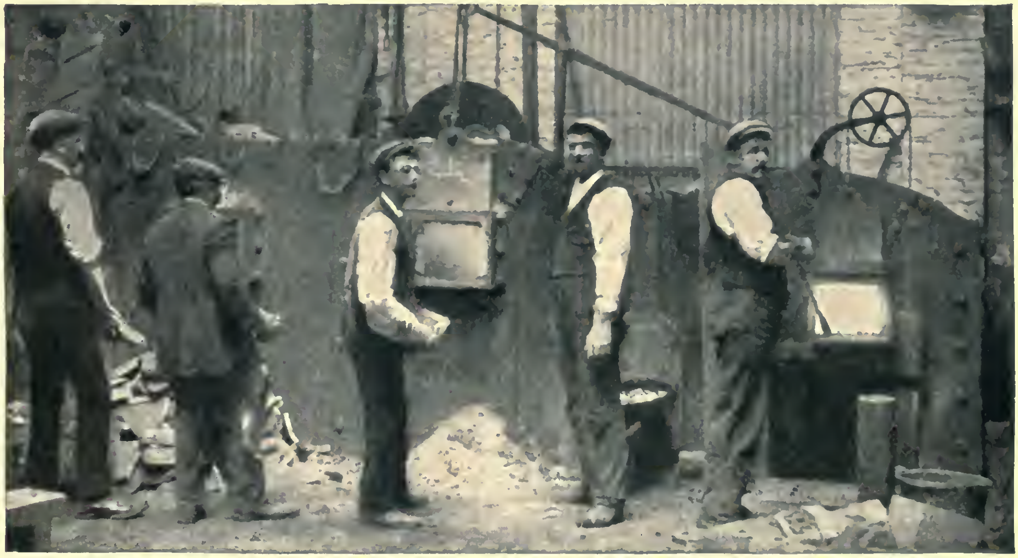
THE INSIDE OF THE COMPLETED MOULD



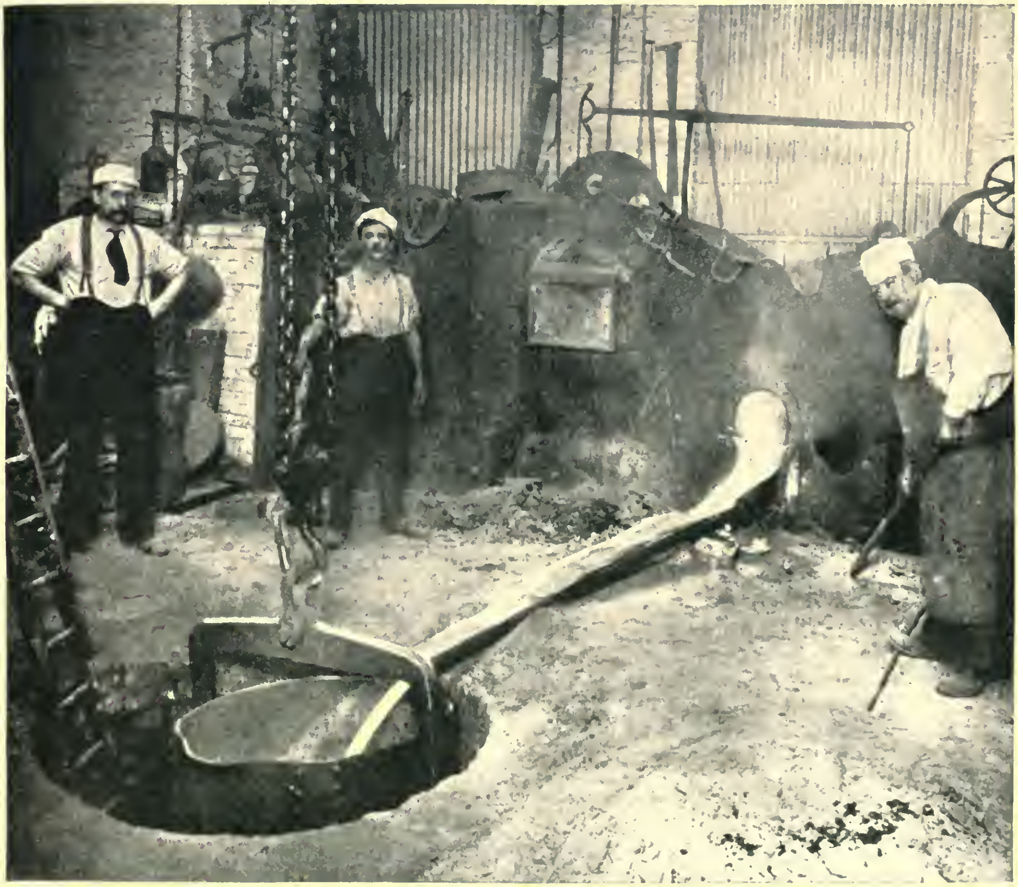
PUTTING THE MOULD OVER THE CORE

Bells are cast by pouring molten metal into a mould, with a core inside to form the shape of the bell. These pictures show the core and mould being made. First the core is made, then a false clay bell is modelled round it, and finally a mould is built up outside this. The whole is baked, and then the mould is raised, the false bell taken away, and the mould lowered again over the core ready for the molten metal to be poured in. The whole bell is built upon an iron plate covered with clay.

MELTING THE METAL FOR THE BELL

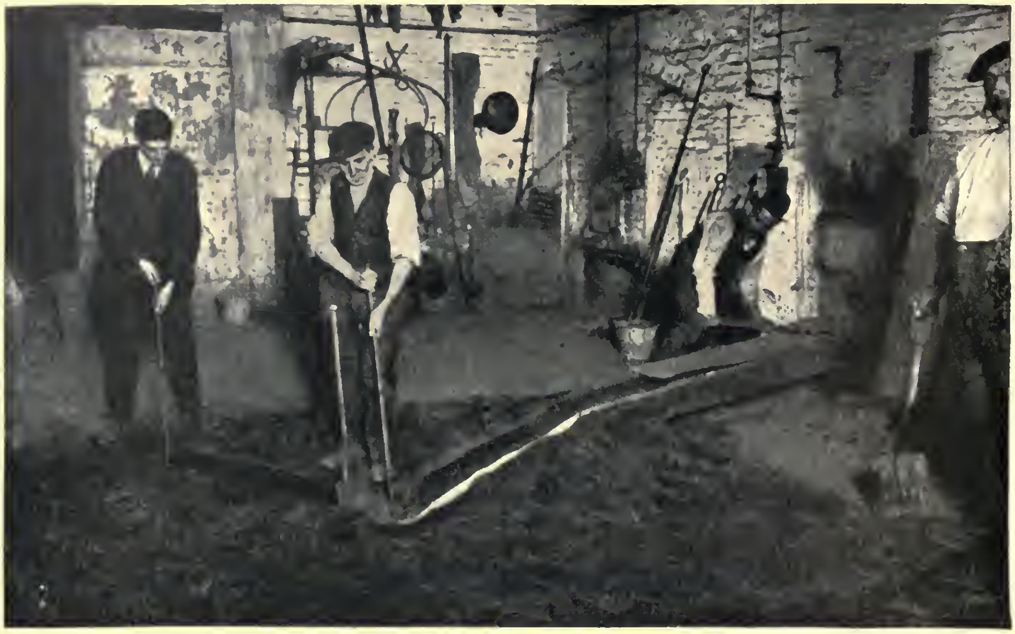


Bells are made of a mixture of copper and tin, which, after long experience, has proved to be the most suitable metal that can be used for the purpose. Here the ingots of metal are being put into the furnaces at a large bell foundry in London.



As soon as the metal is in a molten state the furnace is tapped, and the metal is run into a vessel called a ladle, which is suspended in a pit below the level of the furnace. The ladle can be moved about by great chains working on pulleys. In America bells are usually cast above ground to avoid the danger of gas explosion.

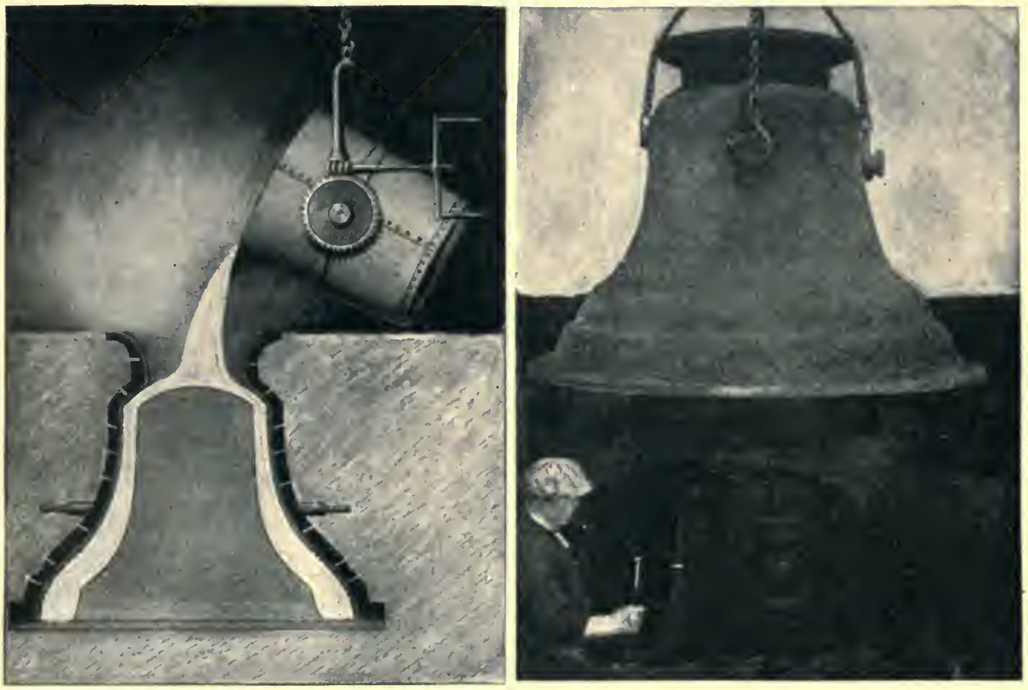
THE MOLTEN METAL RUNS INTO THE MOULD



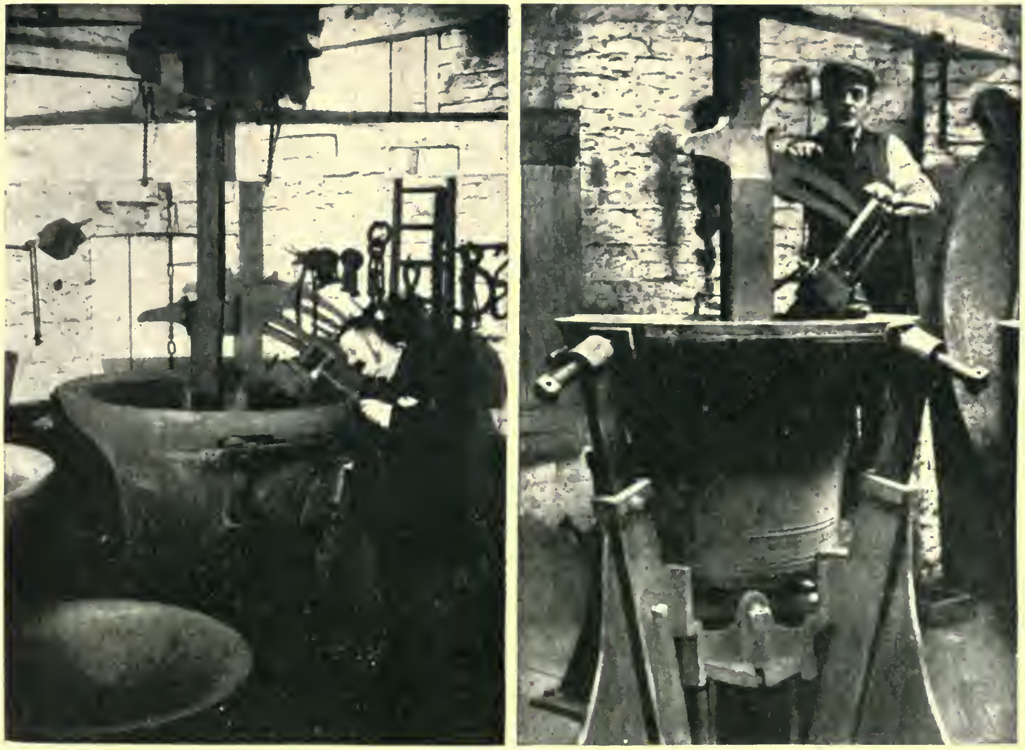
In making very large bells the mould and core are usually arranged in a pit near the furnace, and the metal is run in direct, as shown in this picture, without being first put into a ladle. The greatest care is taken in tapping the furnace.

In smaller bells the metal is poured into the mould from the ladle, which is gradually tilted by means of a toothed wheel and screw worked by a handle. The details of this clever yet simple device can be seen in the diagram on the next page.

THE BELL IS MADE AND TUNED TO MUSIC



The diagram on the left explains how a bell is cast by pouring metal between the core and the mould. The mould of clay has an outer framework of iron perforated with holes, through which the moisture in the clay can escape when it is baked. On the right the mould is being raised after the metal has cooled, and the actual bell is shown in the pit, ready to be tuned.

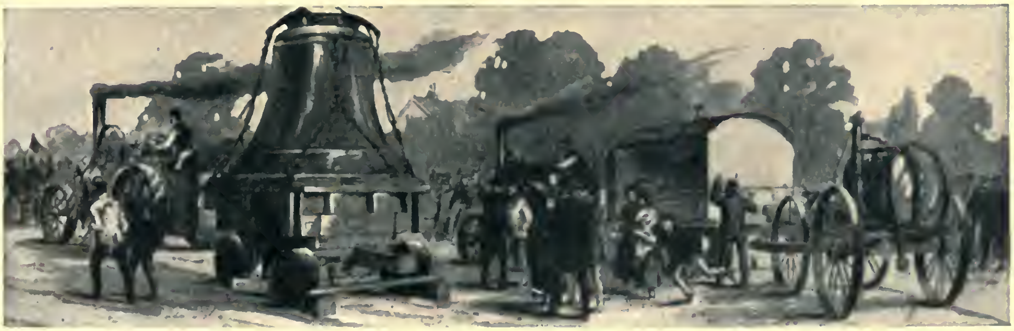


Bells are so beautifully cast that they rarely need any tuning. Sometimes, however, the note is flat, and this is sharpened by reducing the thickness of the bell, as the man is doing on the right. On the left the note of a bell is being tested.

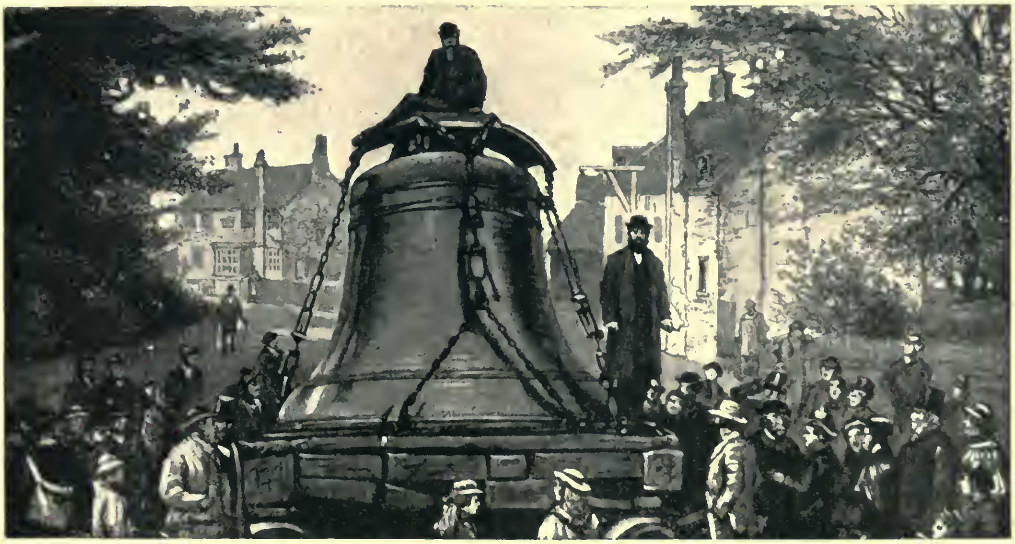
THE FIRST RINGING OF A GIANT BELL

When a big bell is cast, the metal is left in the mould for several weeks to cool. Then, at last, the mould is removed and the bell taken out of the pit, and as it is raised there is a moment or two of great anxiety while the workmen examine it to see whether it has cracked in the cooling. Here an enormous bell is being rung for the first time, though a very big bell is not usually swung, but is struck on the outside The great bell of Moscow was left in the earth over a hundred years,

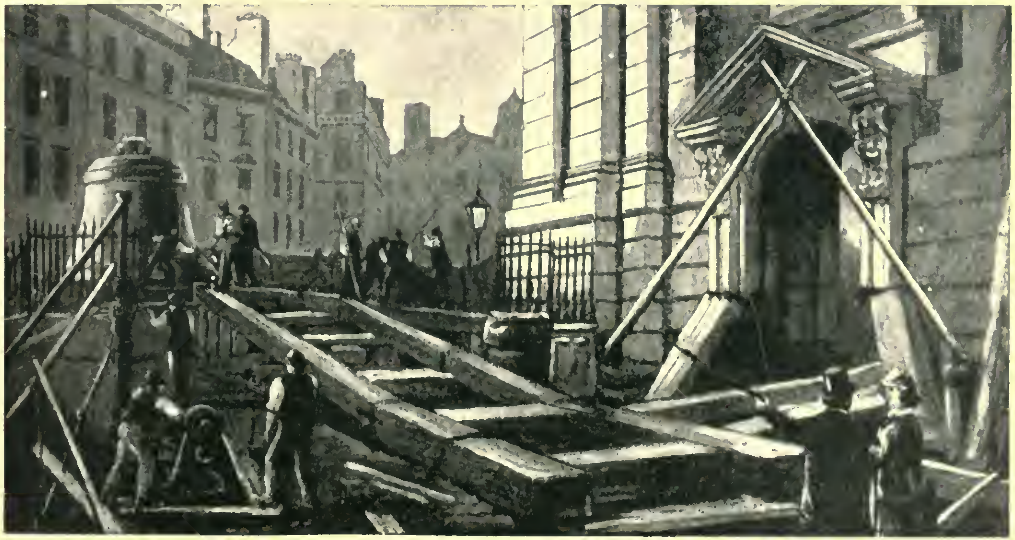
HOW GREAT PAUL REACHED ST. PAUL'S



The biggest bell in England is Great Paul, which weighs seventeen tons, and hangs in St. Paul's Cathedral. It was cast at Loughborough, in Leicestershire, and was brought to London on a great trolley, in the manner shown in this picture.

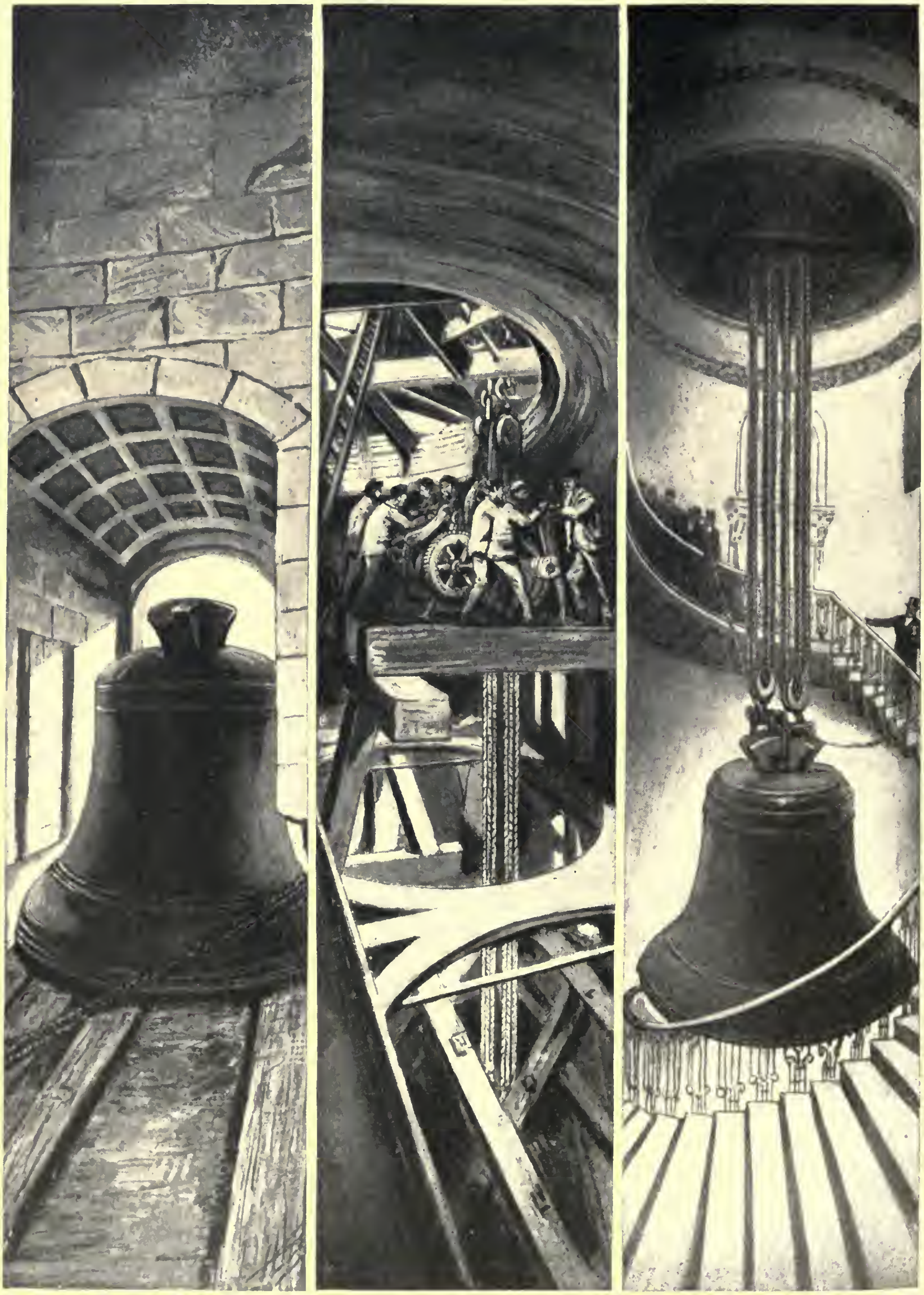


A pilot rode on a tricycle in front of the bell, and another man walked with a red flag. There was also a hut full of tools on wheels and a great tank of water for the traction-engines. Wherever the bell stopped, crowds of people gathered round.



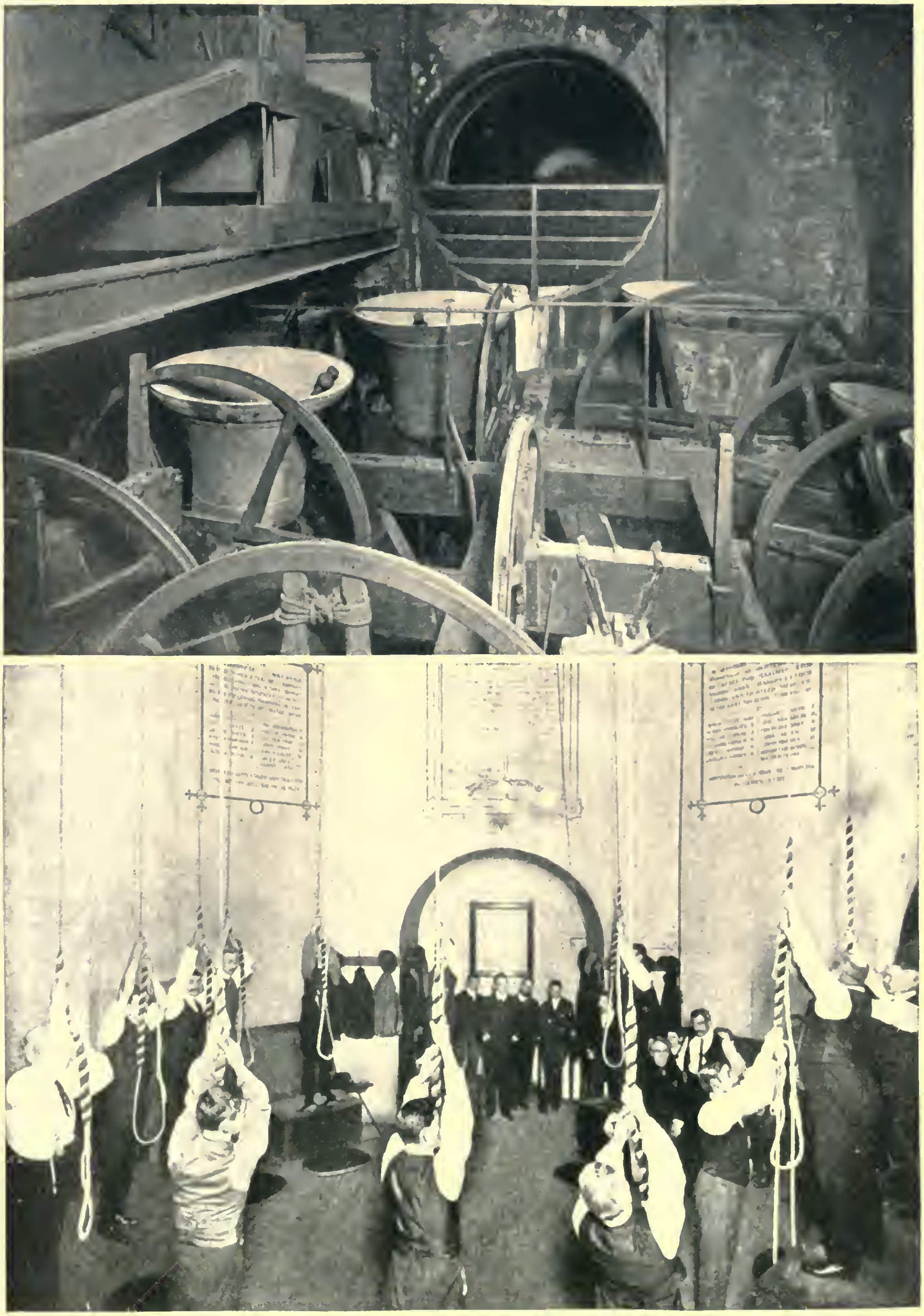
At last it reached St. Paul's, where the solid stone walls of the doorway had to be cut away for the bell to go in. It was slid to the bottom of the tower where it now hangs, along a timber-slope that had been well greased with tallow.

PUTTING GREAT PAUL IN HIS PLACE



When Great Paul was landed safely at the bottom of the bell-tower of St. Paul's Cathedral, as shown on the left, a series of pulleys and winches were placed in position and the work of hoisting the bell by means of great ropes, each more than six inches round, was carried out as seen in the second and third pictures. It took no less than a day and a half to raise the great bell and the movement as it went up the tower was so slow and gradual as scarcely to be seen by the eye.

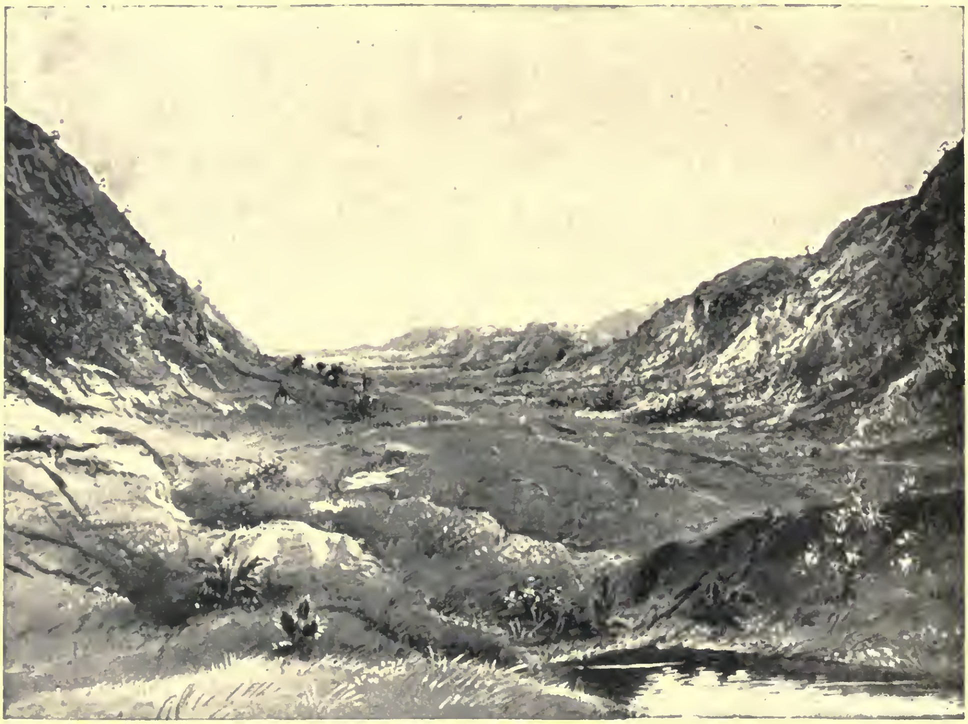
THE NEW YEAR PEAL AT ST. PAUL'S



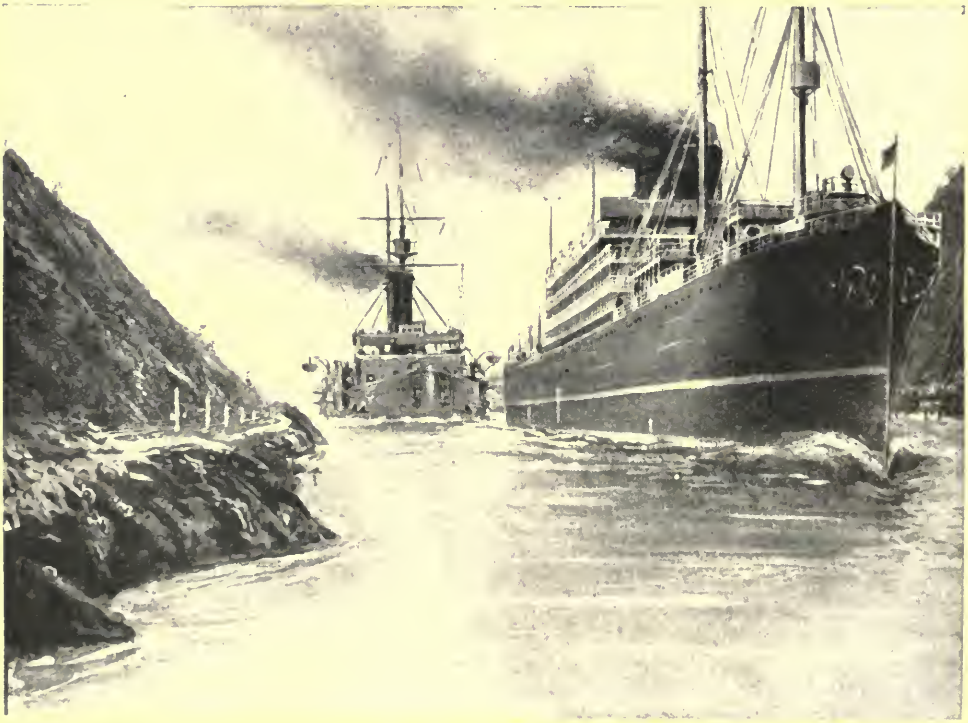
Bell-ringing has been brought to a fine art in England. There are societies all over the country, whose members vie with each other in what is known as change-ringing—that is, the ringing of a number of bells in varying orders. Five thousand changes is reckoned a peal, and here we see the ringers of St. Paul's Cathedral ringing a peal upon the bells which are shown in the belfry above. To ring all the possible changes on 24 bells would take more than 17 billions of years

Upper picture from The London Sphere, through the N. Y. Herald.

BEFORE AND AFTER THE GREAT CANAL



In this picture we see what the Culebra mountain looked like before the engineers began to cut through it. If we compare this picture with the picture below we can imagine the enormous slice of mountain that has been cut away.



Here we see the same place as it appears after the canal is finished. That ships are now able to steam right through America from one side of the New World to the other in a few hours, seems almost beyond belief.

PANAMA THE WONDERFUL

A THING has happened in the world that is almost beyond belief.

It is almost beyond belief that a mountain has been cut in two, and that the Pacific Ocean is flowing through it. It is almost beyond belief that a way has been made which brings the Atlantic sea-front of America four thousand miles nearer the Philippine Islands and New York eight thousand miles nearer San Francisco. It is almost beyond belief that ships are sailing at this moment through the Panama Canal, climbing up from the Atlantic to the top of the stairs that lead down to the Pacific.

All this is more thrilling and wonderful than words can make it.

But more wonderful than that, though the canal has cost as much as thirty battleships, and will cost five million dollars a year to keep up, is the work that made the cutting of this great waterway possible. Since the world was made man has done nothing quite so great as this; since man first found power he has made no nobler use of it than in sweeping away the foulest scene on earth and putting in its place a smiling land.

It is like the real beginning of the world, all that has gone before being simply learning. Yet there was a beginning long ago. I like to think of it; it was one morning when Power was born into the modern world. The King of England had heard of a young man in Glasgow who was talking of making engines, and the King of England went to see him.

Now, of course—so strange are the things of this world—even a king may be ignorant and a plain man may be wise, and there never was so beautiful a case as this of a plain wise man and a foolish king. For the king was very superior in his royal ignorance; he would put this little man in his place; and so, with a patronising air, George the Third went up to James Watt, and asked, "Well, my man, and what have you to sell?" Let us put "my man's" words in bold type; they are worthy to be addressed to a king. Said James Watt to George the Third:

What kings covet, may it please your Majesty—Power.

Time was flying past them both, and the plain man and the king were passing from the earth to whatever lies beyond; but long after the world will have forgotton that George III. lost America it will remember that James Watt made an engine run by steam.

What kings covet—Power! Well, men have found it now, and, though most kings and governments are sleeping with the key of a new earth under their pillows, for once a government has sent out a plain man to use to the utmost the power that was ready to his hand.

And this is the story of what the plain man did with Power.

The Way Between the Oceans

The old Panama has gone for ever, and men will hardly believe what they read of it in the years to come. The narrowest point of the mighty American continent, it remained for centuries the great highway between the Atlantic and Pacific Oceans. A glorious natural way it must have been in the days when the treasure-hunters of Spain passed through it with their captures; in the days when it came into the greatness of Spain and figured on the maps as Darien; in the days when Sir Francis Drake climbed a tree there and saw the Pacific Ocean, praying that the day might come when he would sail the unknown sea in an English ship. And a glorious way it has now become once more, so that again men will look out upon the world from there, and, remembering the famous lines of Keats, will be moved by what they see, as Balboa was moved

when with eagle eyes
He stared at the Pacific—and all his men
Looked at each other with a wild surmise—
Silent, upon a peak in Darien.

And there were big things even then in Panama, for a King of Spain is said to have looked out from his palace windows, shielding his eyes and saying that he was looking for the walls of Panama, " for they had cost enough to be seen even from there." It was a kingly jest, but it speaks eloquently to us even now of the riches of Old Panama.

Yet all this time the power of Panama was not with the King of Spain, nor with his treasure-hunters, nor with the buccaneers who fought and scattered desolation everywhere in this way from sea to sea. The kings of Panama were Stegomyia and Anopheles, who had no throne of gold, but held the power of life or death over every man and woman and child in Panama. They took no taxes, made no laws, raised no armies, and commanded no respect. No traveller in Panama bowed down to them; for all the pomp that surrounded them, these kings of Darien might have been the humblest creatures of the dust. Yet in their grip lay the destinies of this beautiful land; without a single word, without a single sword, they drove back mighty hosts of men and broke the power of nations. When, after hundreds of years, Europe sent out its engineers to dig the Panama Canal, these kings were reigning still, and tons and tons of steel, crumpled-up engines, and bars of iron that trees have picked up and twisted round their branches, tell the tale of how Stegomyia and Anopheles dealt with them.

Like the Shadow of Death they reigned over Darien; here they held sway unmolested for four hundred years. It is right that we should have their portraits in our gallery, for there have not been in the history of mankind two more powerful members of a ruling race.

Here is Stegomyia **And here is Anopheles**

THE CONQUERORS OF OLD PANAMA

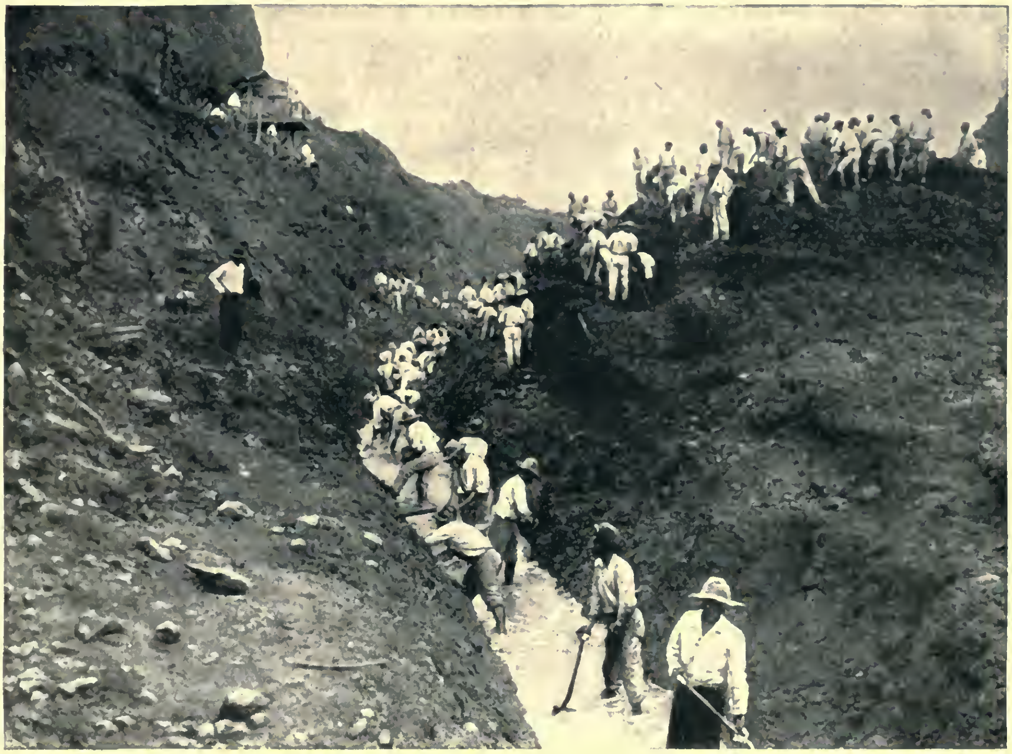
For generation after generation they consumed the life blood of the people who lived in this beautiful region of the earth. The heat of Panama is such as only tropical travellers know; the terrific rainfall is almost beyond our imagination; and so, in a country with unmade roads, with only the roughest tracks beaten down by the tramping feet of centuries of passers-by, there was nothing but encouragement for stagnant water everywhere. The moisture and the warmth of the rich soil gave rise to forests of vegetation, thick growths of huge plants and deep jungles of hundreds of varieties of grasses, in which insects lived in countless myriads; and so there poured out into still lakes and pools and marshes a rushing stream of decay, dead and dying animal and vegetable matter, which never seemed to end, but lay there year by year, until it seemed almost natural that a city of ten thousand people, like Colon, should have within it a hundred and fifty thousand graves.

And so Old Panama came to be unfit to live in, a beautiful place befouled, until an English traveller declared that " in all the world there is perhaps not now concentrated in any spot so much swindling and villainy, so much of foul disease, such a hideous dung-heap of moral and physical abomination."

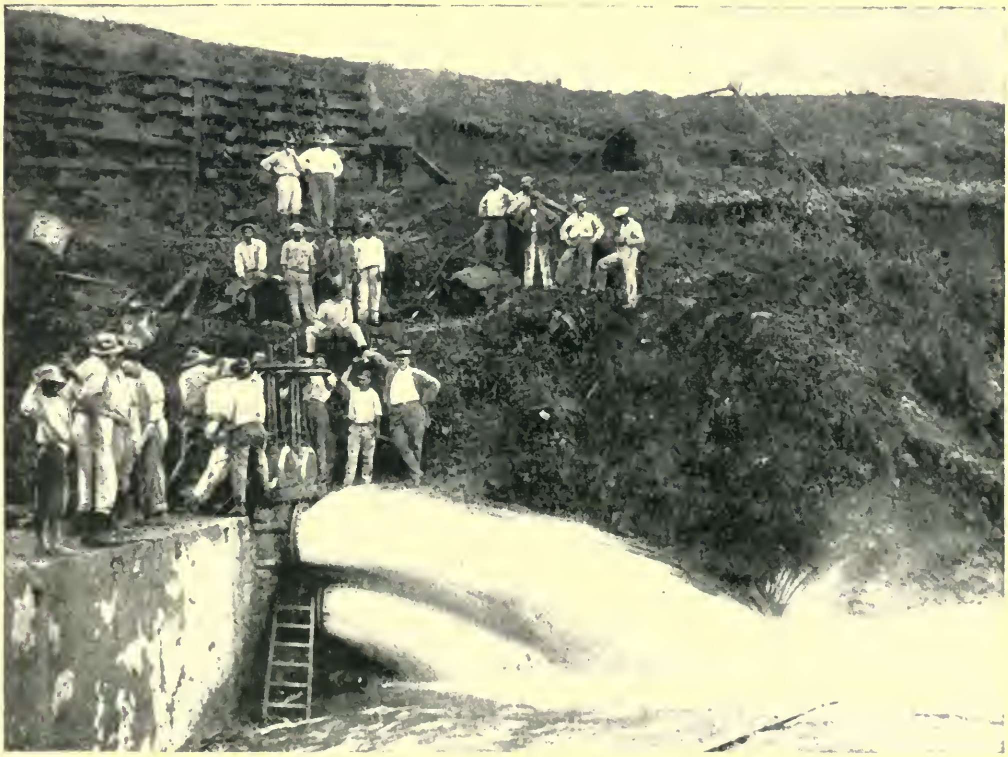
The Giants Who Came and Fell

Sir Isaac Newton was able to do his work because he stood on the shoulders of giants, he said, and the Americans have dug the Panama Canal because they stood on the shoulders of the poor Frenchmen who tried and failed. Let us remember them, giants that they were, brave men who faced disease and death, and did not quail.

This is what happened when the great French engineer who had dug the Suez Canal, Monsieur de Lesseps, set out to cut America in two at the narrow isthmus of Panama. There was a French consul who advanced an engineer the money for a suit of clothes one day, and invited him to lunch the next; but the engineer did not come. He had died of yellow fever at three o'clock in the morning, and was buried at dawn in the new suit he had just put on. There was another Frenchman, the first Director-General of the Canal, who spent one hundred thousand dollars on a house on the top of a hill; but before the house was finished his wife and son and daughter had died of yellow fever, and the Director-General went back to France alone, a broken-hearted man. Another man was sent to take his place; he settled down and began his duties, and died of yellow fever,



CUTTING A MINIATURE CANAL THROUGH A LANDSLIDE AT CULEBRA MOUNTAIN



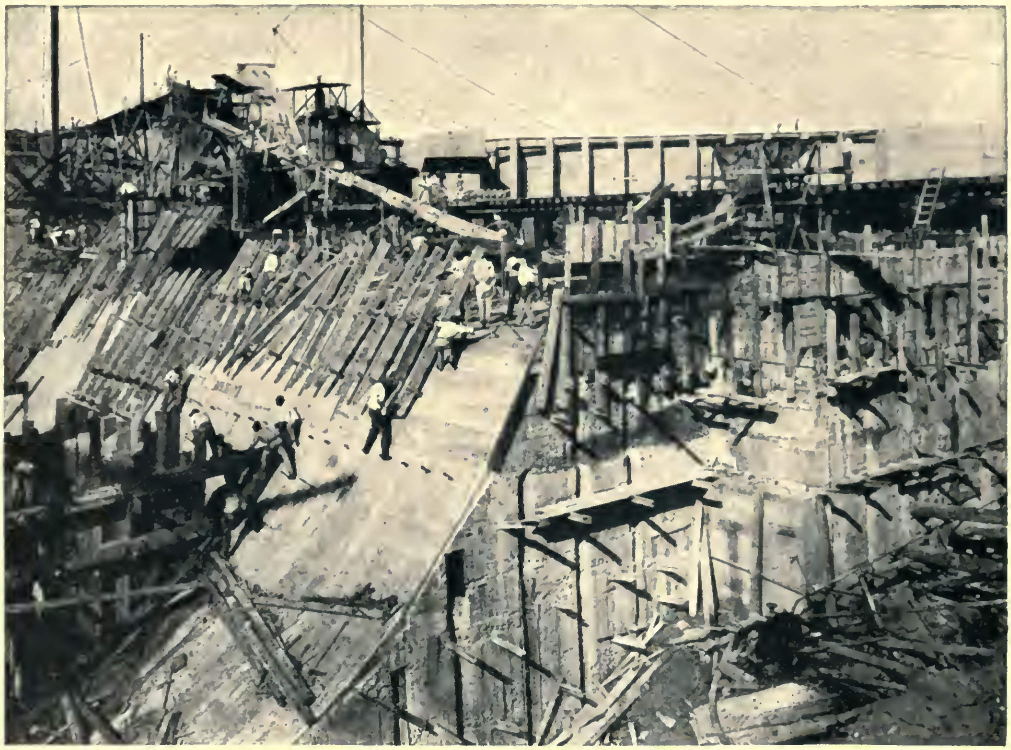
THE WATER FLOWS INTO THE CULEBRA CUT THROUGH FOUR PIPES TWENTY INCHES WIDE

THE MOVING OF THE EARTH AT PANAMA

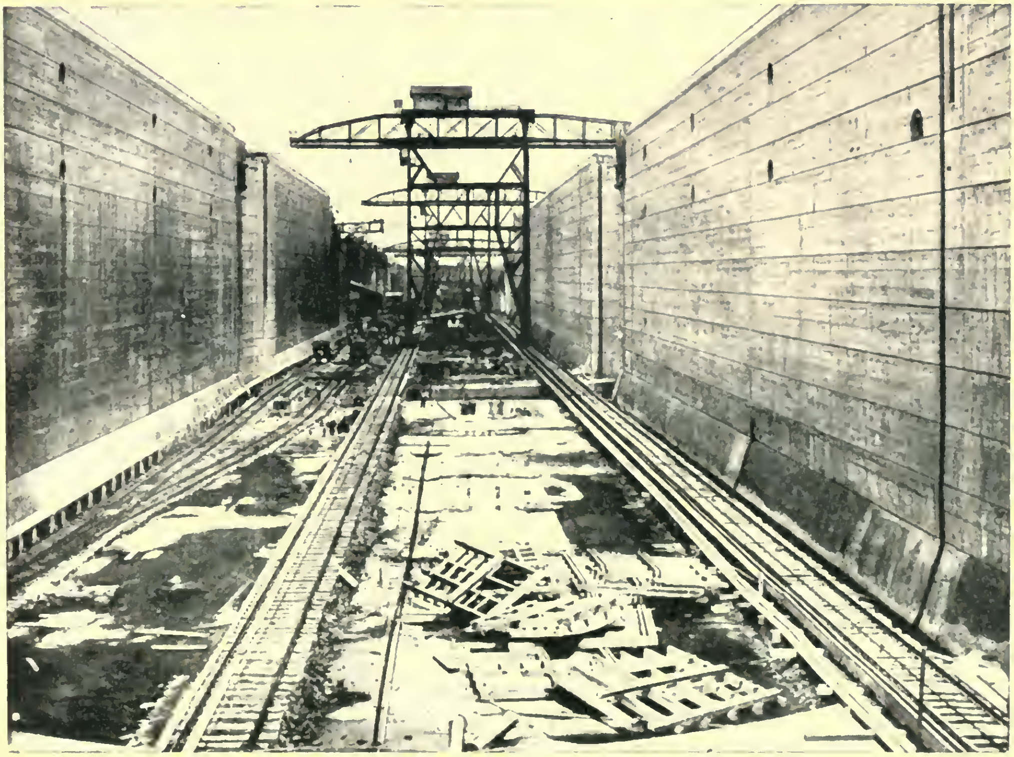
SOME OF THE 200 MILLION CUBIC YARDS OF EARTH REMOVED TO MAKE WAY FOR THE SEA

THE SIGHT THAT WILL NEVER BE SEEN AGAIN—THE DRY BED OF THE PANAMA CANAL

THE WORKSHOP THAT WAS 45 MILES LONG



WHAT THE WORKSHOP LOOKED LIKE ON A WORKING DAY



THE HUGE CRANES THAT CARRIED THE CONCRETE THAT FILLED THE WALLS

A thousand men were sent to dig, and every man was dead within a year—from yellow fever. Another thousand took their place, and before the first year ended the second thousand were dead too. Sixty-nine men in every hundred died at times; ten thousand after ten thousand brave workmen were stricken and fell.

So Death went about in Panama, and nothing could stop its terrible march. It was like poison walking in the streets. No man was surprised if the friend he had seen in the morning was lying in a grave at night. Yet, in spite of Death, the Frenchmen went on digging, and they did as well as the Americans could have done in those dark days. For they were fighting Stegomyia and Anopheles; they were in the grip of the invisible armies of Death, and their very efforts to save their poor stricken men were destroying the lives of their comrades. There are few things in the history of the world more pathetic than this—that, in those days before the truth was known, the French doctors, to keep the insects out of the beds of the sick men, stood the bedsteads in bowls of water, *in which the mosquitoes that spread the disease were bred.* So near to these poor doctors was the mysterious enemy which baffled them.

With fifty thousand men, and over two hundred million dollars, the great De Lesseps failed. He died broken hearted in Paris, and his name is written across Panama in heaps of rusty iron and ruined machinery. There it lies in swamps and jungles, proclaiming to all the world the failure of human power against an invisible foe. It is all that is left of ten years of the labour of a great host of men, and the spending of a *dollar for every minute of time since Balboa, in 1513, first looked out from his peak in Darien.*

The Giants Who Stayed at Home

And now we must come back to France, for while the Frenchmen who went to Panama gave up the work and gave up their lives, another Frenchman stayed at home and led the way to the Panama Canal.

It was Louis Pasteur, looking through his microscope, that set men searching for the invisible enemies of Death at Panama, and led to the arrest and trial and conviction of Stegomyia and Anopheles on a charge of destroying hundreds of thousands of lives. For what Louis Pasteur found was this.

Man is truly at the top of the world, the "highest yet" that Life has known. But man has against him, in his march of conquest, myriads of smaller creatures which, often before he knows it, sting him and poison him and may destroy him. Sometimes these creatures live on a man's body, so that we call them parasites, because they live on others; sometimes they have smaller parasites which live on them, so that even a harmless insect may carry a poisonous parasite and give it to a man with its sting. And this great discovery of one Frenchman, if it had been made a little while before, would perhaps have saved the lives of all those Frenchmen who died in digging the canal, for it led to the discovery of the hidden enemy of life in Panama, and to the sweeping away for ever—if we want to do it—of two of the greatest enemies that the human race has ever known.

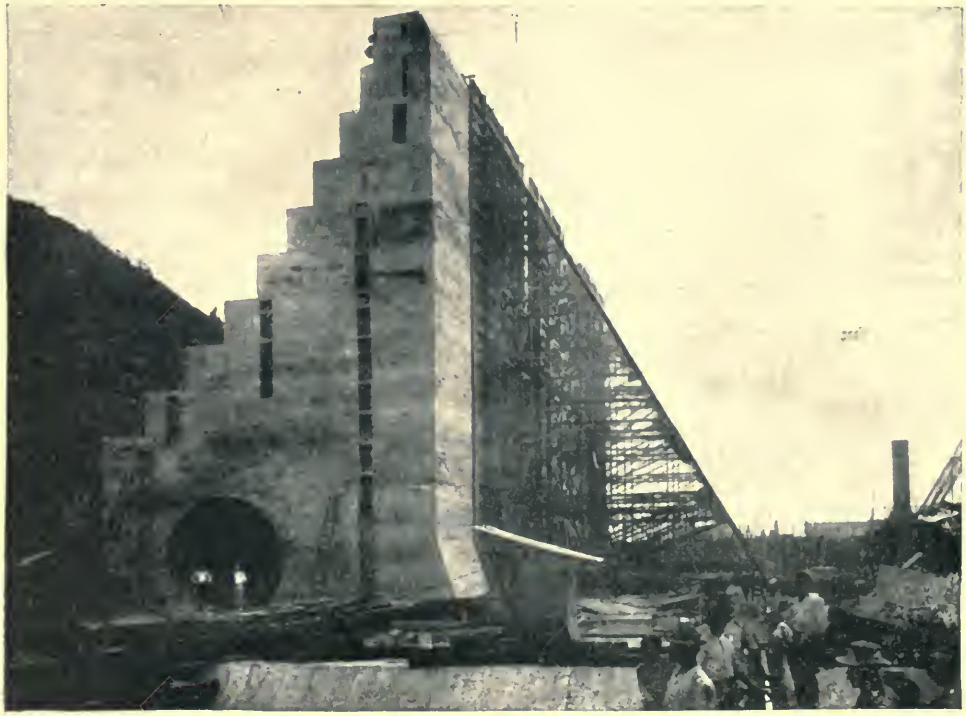
We need not stop to trace here all the steps in this great conquest of the enemies of man—to recall the work of the great Pasteur himself; of his countryman, Dr. Laveran, who studied parasites in Africa; of his other countryman, Dr. Beauperthuy, who lies in a humble grave in the West Indies, and of Dr. Charles J. Finlay, of Havana, both of whom years ago pointed the way to the great discovery that the real enemy was carried by the mosquito; or of Sir Patrick Manson, whose work in London—still being carried on—was so valuable, and entitles him for ever to the grateful memory of mankind. But we must look for a moment especially at the work of the men who crowned this quest of knowledge with success—Sir Ronald Ross in England and Dr. Walter Reed in America.

It was Dr. Ross who studied Anopheles and Dr. Reed who studied Stegomyia, and what they proved was that Stegomyia carried in its body the author of yellow fever, and that Anopheles carried within it the author of malaria, so that a bite from one of these mosquitoes might any time bring death. The parasite of Anopheles is known, that of Stegomyia is still unknown; but we know that both these fearful parasites inhabit the bodies of the mosquitoes, which give them to man when they suck his blood. Half their lives the parasites spend in the body of the mosquito and half in the body of man, whom for centuries they destroyed.

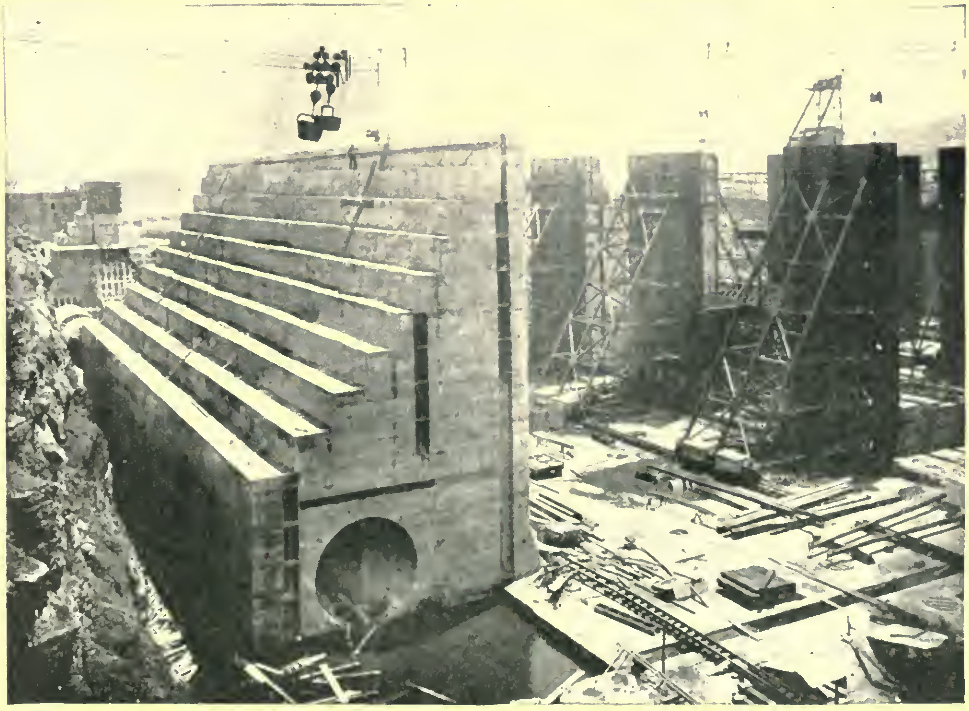
The Unknown Enemies of Man

So, for ages past in the history of the world, two little mosquitoes have carried within their bodies the fearful creatures which have struck down millions of unhappy members of the human race. They have

WALLS THROUGH WHICH THE SEA COMES

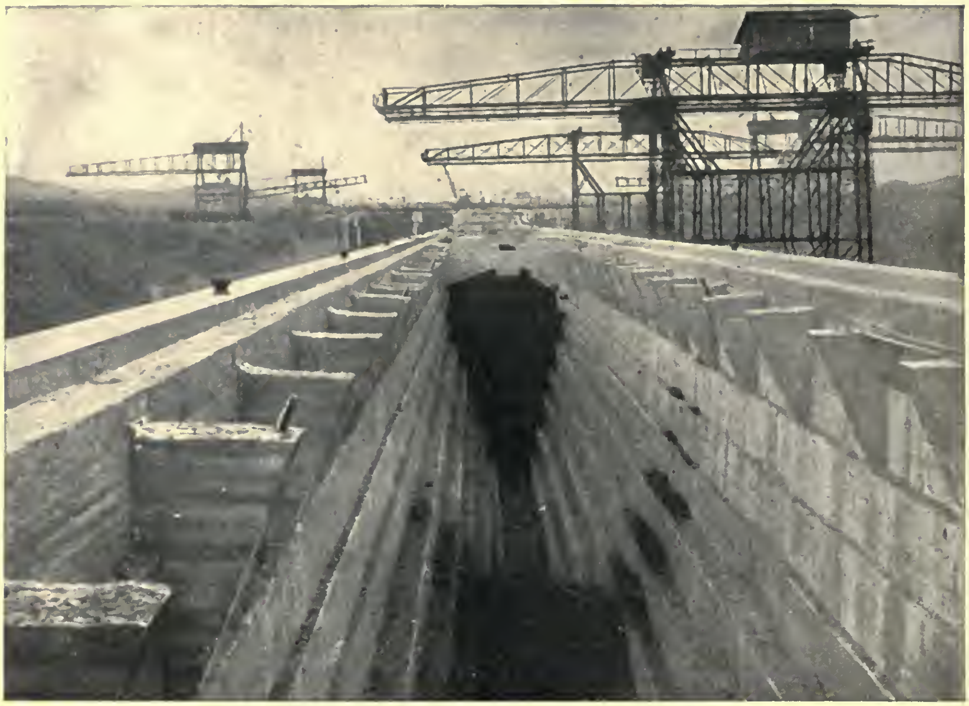


To collect and harness sufficient water a great dam has been built, and by storing flood waters that formerly ran away, a lake of 170 square miles, called Gatun Lake, has been formed. Here we see a wall of the Gatun locks.

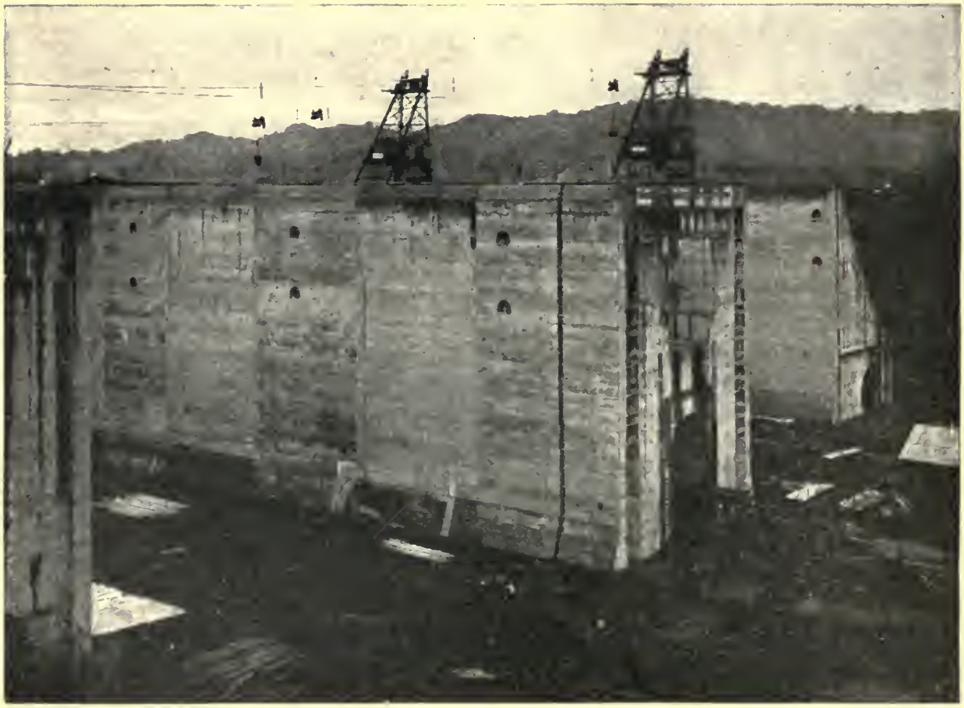


This is another view of the walls at the Gatun locks. The tunnel through which the surplus water flows can be seen. The Gatun dam is the mightiest in the world. Its walls are more than half a mile thick at the bottom.

THE MARVELLOUS WALLS OF PANAMA



Inside one of the great walls before it was filled up with thousands of tons of concrete, showing the enormous strength which has been put into them to resist the sea.



Here is a closer view of the walls of the Gatun locks. Each lock is 1,000 feet long, and the largest liners and battleships are thus able to use them. There are three of them, up which ships climb to the Gatun lake.

held whole continents back from civilisation, and have made tropical countries impossible for white races. These little pools by the wayside, the little pockets of water in the waste places—what a mighty meaning they have had in the history of the world! For in them the mosquitoes breed, so that these still waters—like the pools of water in which the French doctors set the bedsteads in the hospitals—were the very birthplace of these great afflictions that struck down whole races of men. They attack those rich regions of the earth of greatest value to mankind, and they strike down not only the native people who inhabit them, but the carriers of civilisation too—the pioneer, the planter, the trader, the missionary, and the soldier. For ages past the things inside the bodies of these two mosquitoes have been fighting against mankind. They have been, said Dr. Ronald Ross, the principal and gigantic ally of barbarism. "No wild deserts," says he, "no savage races, no geographical difficulties have proved so inimical to civilisation as this disease. We may also say that it has withheld an entire continent from humanity—the immense and fertile tracts of Africa. What we call the Dark Continent should be called the Malarious Continent; and for centuries the successive waves of civilisation which have flooded and fertilised Europe and America have broken themselves in vain upon its deadly shores."

LARVÆ OF MOSQUITOES BREATHING THROUGH THEIR TAILS

A MOSQUITO REACHES THE FULNESS OF LIFE AND LEAVES THE WATER

THE ENEMY OF MAN TAKES ITS FIRST FLIGHT

THE COMING OF THE MOSQUITO FROM THE WATERS

The pages of history are black with the story of these terrible diseases. Yellow fever followed Columbus to America in 1493, and was so bad there that the King of Spain had to throw open his gaols for volunteers. And still, within the lifetime of living men, yellow fever was raging in the same West Indies so that in a few months 69 in every 100 white troops in Demerara perished. There is a sad story of a general who lost his reason when, in spite of all he could do for his brave men, they were struck down in hundreds by invisible bullets.

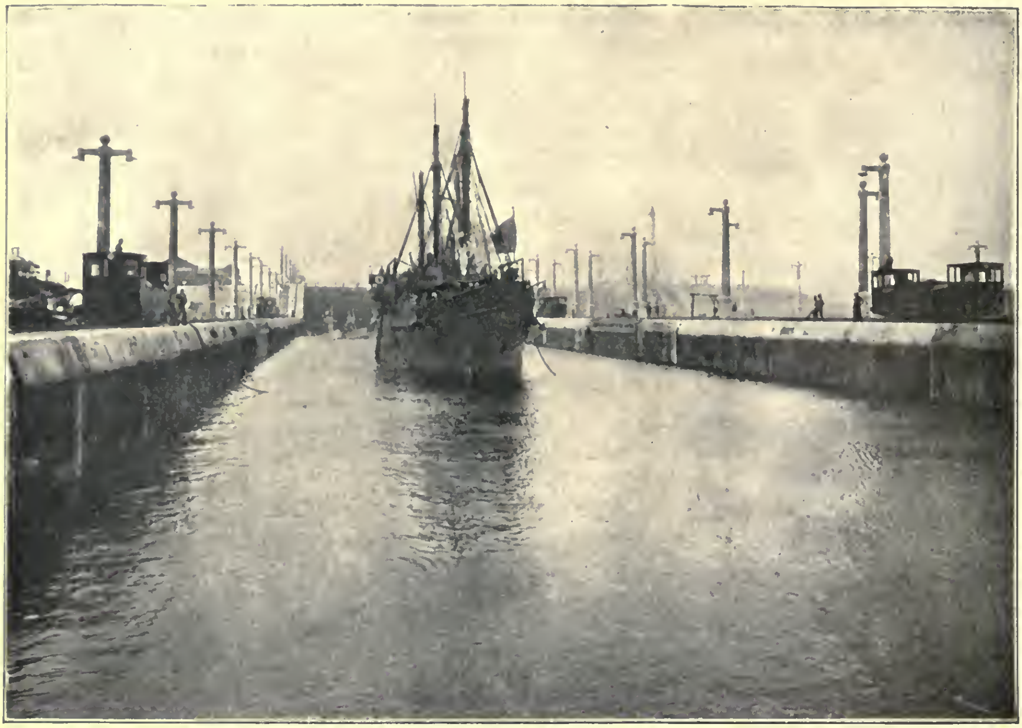
One traveller spoke of it as so terrible that it seemed as if the European carried something in his pocket which, coming in contact with the tropical atmosphere, lit up a conflagration. In Brazil there were 35,000 deaths in one year, and ships rotted in the harbour because their crews died and none could be found to replace them.

Naples was once in the grip of a plague which took 380,000 lives in six months; 144,000 people died in Constantinople in the year Napoleon marched from Moscow; there was a period of three years when 25 million people died from plague in Europe and 30 millions in China alone; and even in 1904 malaria killed a million people in British India, destroying in a single week over 76,000 lives, a number equal to the entire British Army in India.

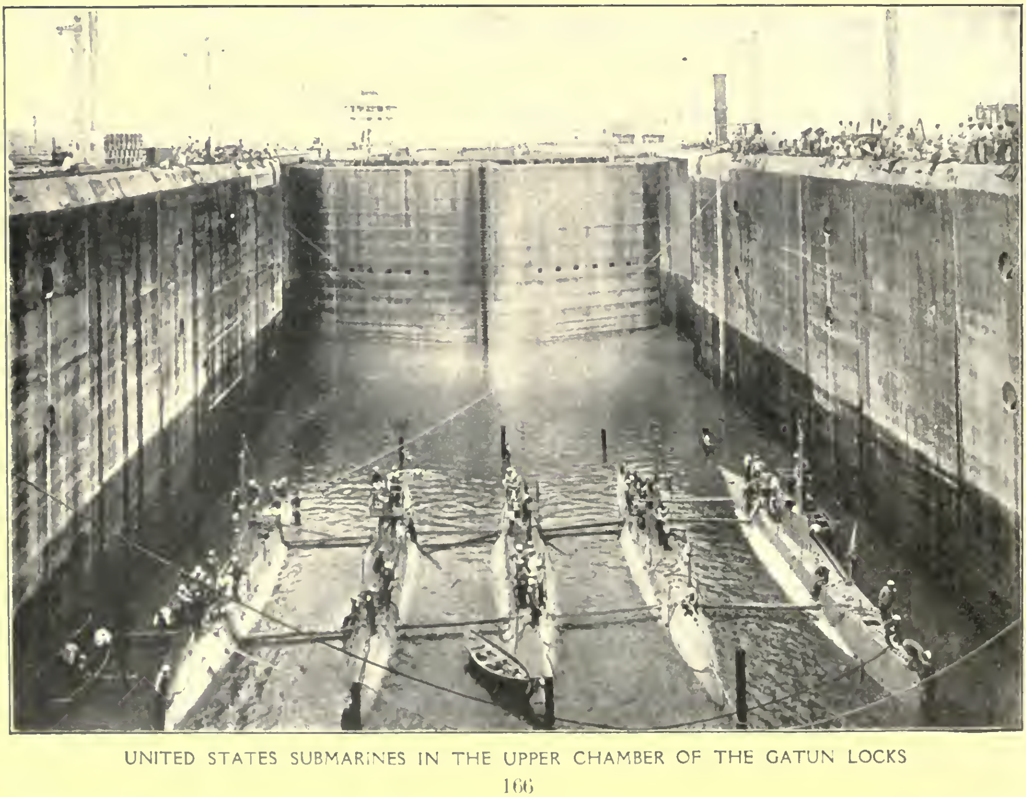
So, all over the tropical world, the mosquitoes came up out of the pools and spread death and misery and disaster among mankind. And *nobody knew it.* It is said that there is an old book in the world, written 1400 years ago, which declares that malaria is caused by a mosquito, and we know that Dr. Beauperthuy declared that this was so in 1856. There is a reference to the theory in a book published in 1846, but the affliction of the human race went on. In their silent warfare against the human race the mosquitoes were winning all the time.

It is pathetic to look back and think of all the wasted efforts to drive back the plague,

INSIDE THE LOCKS WHERE THE SHIPS CLIMB

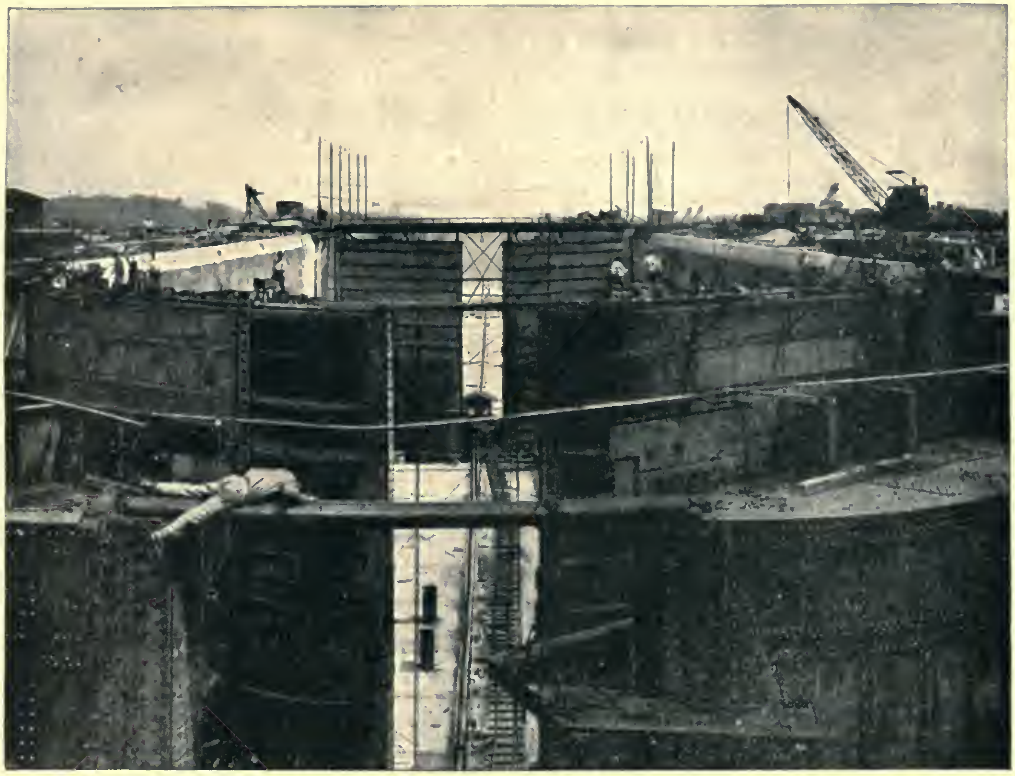


THE SEVERN AND SUBMARINES PASSING THROUGH THE GATUN LOCKS



UNITED STATES SUBMARINES IN THE UPPER CHAMBER OF THE GATUN LOCKS

THE GREAT GATES THAT OPEN FOR THE SEA



THE ENORMOUS GATES OF GATUN LOCK, WHICH ADMIT THE BIGGEST SHIPS

A STREET IN BALBOA, THE ADMINISTRATIVE HEADQUARTERS OF THE CANAL of all the human life and energy and thought and money that poured away in vain attempts to drive the enemy back. Clothing and baggage were disinfected or destroyed; ships were turned away from docks with the dying on board; thousands of tons of stone and cargo were thrown overboard in the belief that they contained the germs of yellow fever or malaria. A pitiful thing it is to think of these desperate efforts to break the power of an unseen foe; there is nothing in all the legends of gods and witches more terrible than this.

The Men Who Found Out

It is good to come, in the story of this great conquest, to the day when Major Ronald Ross sat looking through his microscope in India at the last two mosquitoes that he had to examine. Working eight hours a day at his microscope, tried by the heat and tortured by flies, his sight grew dim, and his body sank with fatigue. But he still went on, gazing intently into the dapple-winged mosquito upon which his microscope was turned. And Dr. Ross did more than gaze upon this little creature in those anxious hours and days when, as we now know, he was on the verge of one of the greatest discoveries that men have ever made: he wrote these noble lines of prayer, which were so soon and so gloriously to be answered:

In this, O Nature, yield, I pray, to me,
  I pace and pace, and think and think, and take
The fevered hands, and note down all I see,
  That some dim distant light may haply break.

The painful faces ask, "Can we not cure?"
  We answer, "No, not yet; we seek the laws."
O God, reveal, through all this thing obscure,
  The unseen, small, but million-murdering cause.

Dr. Ross was bending intently over his microscope as these thoughts filled his mind one night in 1893. He was deeply disappointed, and was about to abandon the examination, when, he tells us:

> I saw a very delicate circular cell, apparently lying among the ordinary cells of the organ, and scarcely distinguishable from them. Almost instinctively I felt that here was something new. On looking further, another and another similar object presented itself. I now focussed the lens carefully on one of these, and found that it contained a few minute granules of some black substance, exactly like the pigment of the parasite of malaria. I counted altogether twelve of these cells in the insect, but was so tired with work, and had been so often disappointed before, that I did not at the moment recognise the value of the observation. After mounting the preparation, I went home and slept for nearly an hour. On waking, my first thought was that the problem was solved; and so it was.

If that waking moment was memorable in the life of Dr. Ross, it is memorable, too, in the life of the world, for it was the beginning of the end of Anopheles, the scourger of humanity, the ravager of continents, the repeller of civilisation. A new door had opened into the temple of knowledge, a new hope had come to the human race.

Here is the thought with which Dr. Ross himself looked out on the world that day. These are his words: "The exact route of infection of this great disease, which annually slays its millions of human beings and keeps whole continents in darkness, was revealed. These minute spores enter the salivary gland of the mosquito, and pass with its poisonous saliva directly into the blood of man. Never in our dreams had we imagined so wonderful a tale as this."

What it all meant to the world we may see from just one instance. Malaria had broken out at Ismailia, in Egypt, and flourished until it was estimated that every inhabitant suffered from it, when Major Ross was sent for. In two or three years he stopped the breeding of mosquitoes, and changed plague-stricken Ismailia into a health resort.

While Dr. Ross was searching in India and discovering the author of malaria in Anopheles, Dr. Reed and three or four comrades in the American Army were searching in Cuba for the author of yellow fever. It was almost certain, after the discovery of Dr. Ross, that the parasite of yellow fever had its home in a mosquito. How this was proved by Major Walter Reed is one of the thrilling stories of the world.

There is no adventure anywhere more instinct with heroism than the search for the author of yellow fever and its discovery in Stegomyia. Even if there had been no gain for freedom in the Spanish-American War, the conquest of yellow fever would have been worth the war a hundred times. A hundred thousand men died of yellow fever in three years under Spanish rule; in forty-seven years 35,000 people died in the city of Havana alone. It was these things that Dr. Reed and his comrades were sent to investigate. One of them died, and the camp was named after him—"Camp Lazear." A great name this will be in the real history of the world if ever its real history is written, and one picture that Dr. Reed has left for us shows us how the spirit of heroes and the love of humanity hovered about this camp.

Two men were wanted for experiments, and two young privates in the army came forward and offered themselves. They were to be bitten by suspected mosquitoes. Major Reed talked the matter over with them, explained the danger and suffering, and then, seeing that they were still determined, promised that they should be generously compensated for their sacrifice. It must have thrilled Dr. Reed to find that the moment he mentioned money these plain American men held back. Both declined to undergo the experiment except on the sole condition that they should have no money reward. Major Reed touched his cap to the privates and said, "Gentlemen, I salute you," and he said afterwards that, in his opinion, this exhibition of moral courage had never been surpassed in the United States Army.

That is how it was discovered that Stegomyia carries yellow fever and gives it to man with its bite, and it is sad to have to say that Dr. Walter Reed gave this discovery to the world as almost his last service to it; for he died soon after, having earned for himself the gratitude of all men living and all men to be born.

So the knowledge that is power came into the world. Now, at last, the world came to close grips with its mortal enemies.

The Plain Man in Power

Now the Panama Canal could be made.

Nothing on earth can stop the human race when it has knowledge and right on its side; nothing but ignorance and folly can defeat mankind.

WHAT A LANDSLIDE MEANS IN THE PANAMA CANAL—A FALL OF EARTH WHERE THE CANAL HAS BEEN CUT THROUGH THE CULEBRA MOUNTAIN

The American Government made up its mind to finish the work the Frenchmen had begun. They were to cut a continent in two at the narrow point from Panama to Colon, and let the world's ships sail through. They sent thirty, then forty, then nearly fifty thousand men to do the work, and made one man responsible for them. His name was Gorgas, and this is the manner of man he is, according to himself. He was speaking at a Baltimore university, and in his speech to the boys there he recalled his boyhood in the time of the Civil War.

I first came to Baltimore about forty-five years ago—a ragged, barefoot little rebel, with empty pockets and still more empty stomach. My father had gone south with Lee's army. At the fall and destruction of Richmond, my mother's house, with all that she had, was burned, leaving her stranded with six small children. She came to Baltimore, and was there cared for by friends. These memories are vivid with me, and can never be effaced.

Colonel Gorgas, who held the office of Assistant Surgeon-General of the United States Army, has taken part in another war since then; he has shown the governments of the world what they can do with power when they have done with quarrelling. Armed with the knowledge Major Ross and Major Reed had given him, Dr. Gorgas went out to Panama and met Stegomyia and Anopheles face to face.

He found there a workshop 45 miles long, and his power extended all the way for five miles on each side. Over 450 square miles this wise, resolute army doctor had the power of a king, he made the law and carried it out. He had neither guns nor powder; he had simply a fact, and the power to drive it home to everybody who lived in his 450 square miles. He knew that two mosquitoes lived in stagnant pools, and he locked them up while the workmen went on digging. He locked up every pool with oil; he drained or sealed up every ditch; he closed every way that could be found through which the mosquitoes could come. Never was there known so great a pouring of oil upon the troubled waters; never was there known so silent a battle between an army of hundreds on one side and hundreds of millions on the other.

On the one side were a few hundred men—doctors and ditchers, drainers and dispensers, oilers and clerks and sanitary inspectors, guarding 40,000 or 50,000 labourers and their families scattered over 450 square miles in about forty camps and villages. They were doing the biggest piece of engineering that has ever been done on the earth, digging a way from sea to sea, cutting up a mountain for the sea to pass through, and building huge walls to hold in the sea as it passed.

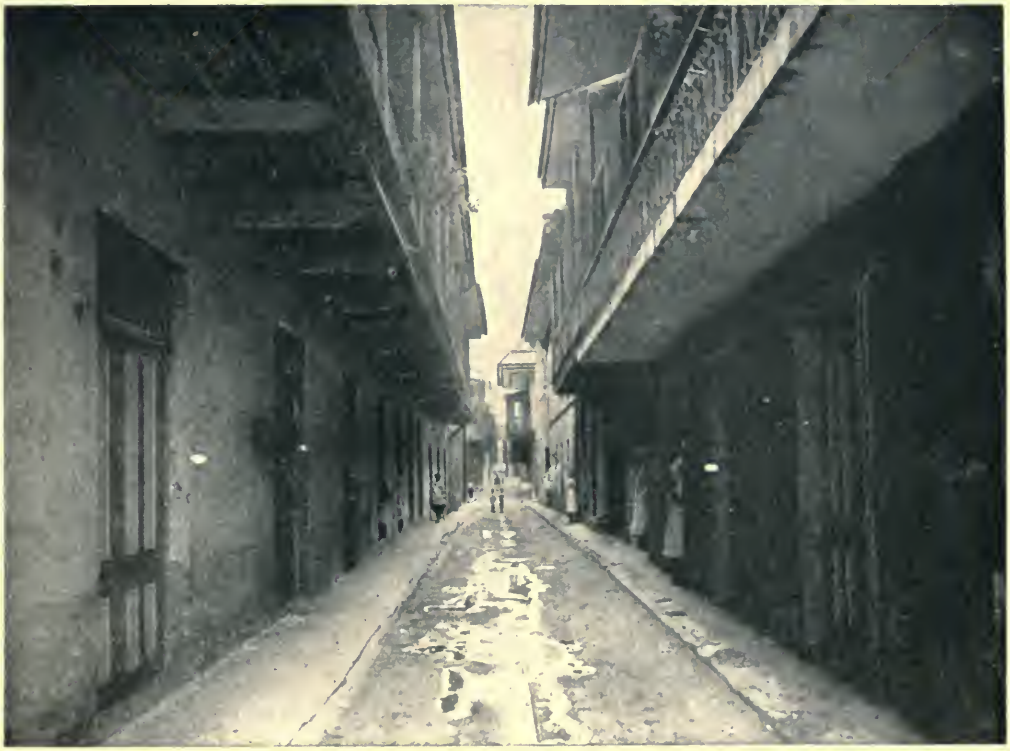
On the other side were millions of mosquitoes of the race of Stegomyia and Anopheles, born in still waters but emerging, with their powers of death, to fly through every door and window to suck the blood of any human being and poison the life-blood of all Panama, as their ancestors had poisoned it for ages, with yellow fever and malaria.

Dr. Gorgas was equal to his opportunity. He was worthy of that long line of men who had lived and died to give him the knowledge that he knew was power. He had against him all the ignorant little people who are always against the man who knows, but he stood firm, like a strong man with the eyes of the world upon him. He screened up all the houses, and ordered every household to cover up all vessels that held water. He drained lakes and swamps that had never been drained before, and poured out the filth of ages to the sea. He drained every ditch and pond that could be drained; those that could not be drained he oiled, so that the mosquitoes in them could not breathe. He cut grass jungles to the ground, destroyed all vermin, and burned all rubbish. He raised all buildings up above the ground, and covered them with fine wire screens. He screened every train, and on every train he put a hospital car. He made every man in Panama a total abstainer, for he ordered alcohol off the ground. Fifty thousand strong teetotallers have done the greatest piece of work the modern world has ever seen.

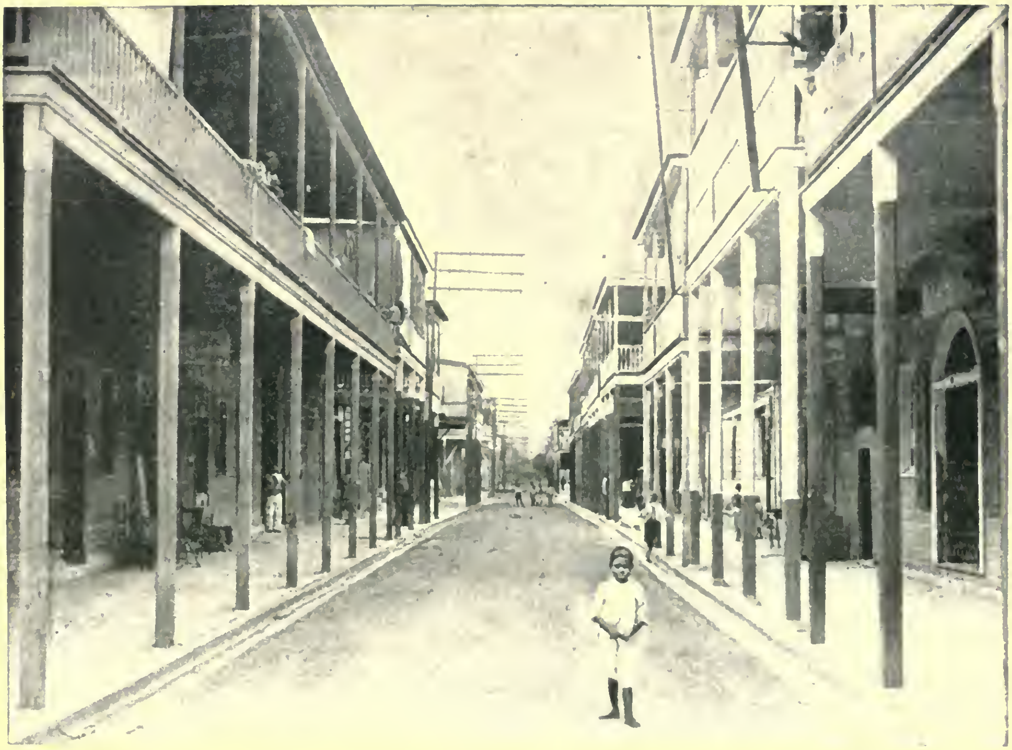
A marvellous thing it is these men have done, these troops of workmen with their giant machines, with a hundred excavators, twenty dredgers, five hundred locomotives, and five thousand trucks, pumps, elevators, cranes, and tugs. Tremendous machines there were which broke up mountain peaks and carried off enormous rocks, which plunged huge shovels into water and brought up hundredweights of mud, which unlocked a train of fifty wagons at one stroke: and it is not surprising that over 200 million tons of earth have been moved away, equal to a tunnel through the earth from side to side. It is no surprise to know that in such a workshop there was a fine spirit of rivalry among the men of the three great divisions—the Central, Atlantic, and Pacific divisions, and that strong men worked like schoolboys to beat the record.

If a machine broke it was thrown down to strengthen an embankment; if an engine overturned there was little time to rescue it. There was no time, evidently, for quarrelling or abuse, for Official Circular number 400 gave notice that "the use of profane or abusive language by foremen or others in authority, when addressing subordinates, will not be tolerated." A fine thing it must have been to see this workshop forty-five miles long, with men working in comradeship in a great world-cause, and we can understand the spirit of the traveller who was carried away at the sight of it, and wrote these words:

THE STREET OF DISEASE AND THE STREET OF HEALTH



THE STAGNANT POOLS IN THE STREETS OF OLD PANAMA, WHERE THE MOSQUITOES USED TO BREED



ONE OF THE FINE NEW STREETS OF PANAMA FROM WHICH MOSQUITOES HAVE BEEN BANISHED

A region is being shaped anew. Cut, carved, transformed, it has now another form and another outline. Peaks have disappeared, other heights have risen; certain valleys have vanished, others have been born; great rivers have obediently followed the will of man, as in the Arab legend the sea, roaring and foaming, followed the steps of Lalla Muna, the Moroccan saint. And across the yellow virgin earth has at last been opened a deep, monstrous furrow, which the waters now invade. The gigantic shipway passes from sea to sea, and possibly is visible to other planets—a slender, luminous, strange new sign on the old and immutable face of the world.

A LIGHTHOUSE ON THE PANAMA CANAL
The light is flashed automatically from sunset to sunrise

Yet all this mighty work would have been still undone if the doctor had not been king and used his powers of kingship well. Dr. Gorgas and his men worked in four great ways—they destroyed the homes of mosquitoes during the larval stage within a hundred yards of all human dwellings; they destroyed all protection for adult mosquitoes; they screened all houses with wire screens; they destroyed all breeding-places, either by draining stagnant waters dry or sealing them with oil. There were seventeen districts, each with a chief sanitary inspector, a clerk, and a staff of three experts -- one of them wise in mosquito lore; another skilled in ditching, draining, and oiling; and the third a good organiser. Each of these districts had forty or fifty labourers to do the draining, carpenters to keep the screens in repair, and dispensers who went about administering doses of quinine among the workmen. Each inspector was responsible for excess of malaria in his district.

And this is the work they did in these seventeen districts in one year: *Cut down 12 million square yards of brushwood, drained one million square yards of swamp, cut 30 million square yards of grass, maintained three million feet of ditches, emptied 300,000 oil-cans, used nearly three million pounds of quinine, fumigated 11 million cubic feet of house space.*

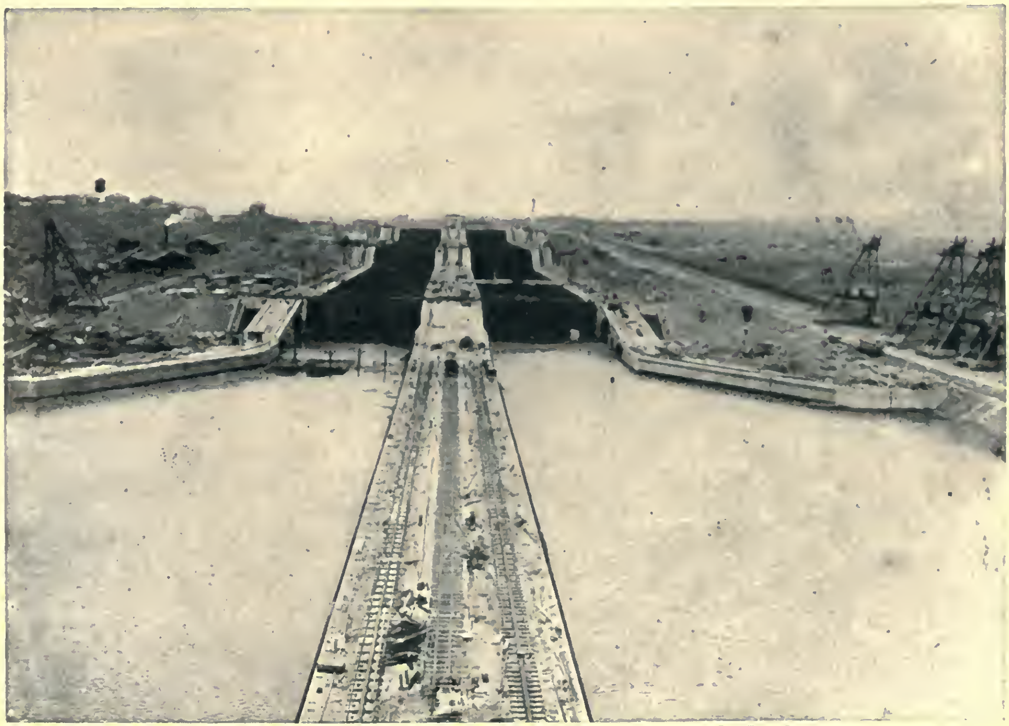
The End of It

And the end of it is that men do not die now in Panama from yellow fever or malaria, that fewer people die in Panama than in New York, and that the death-rate of Panama is now the lowest of any large body of people in the world — less than eight per thousand, and less than three among white Americans.

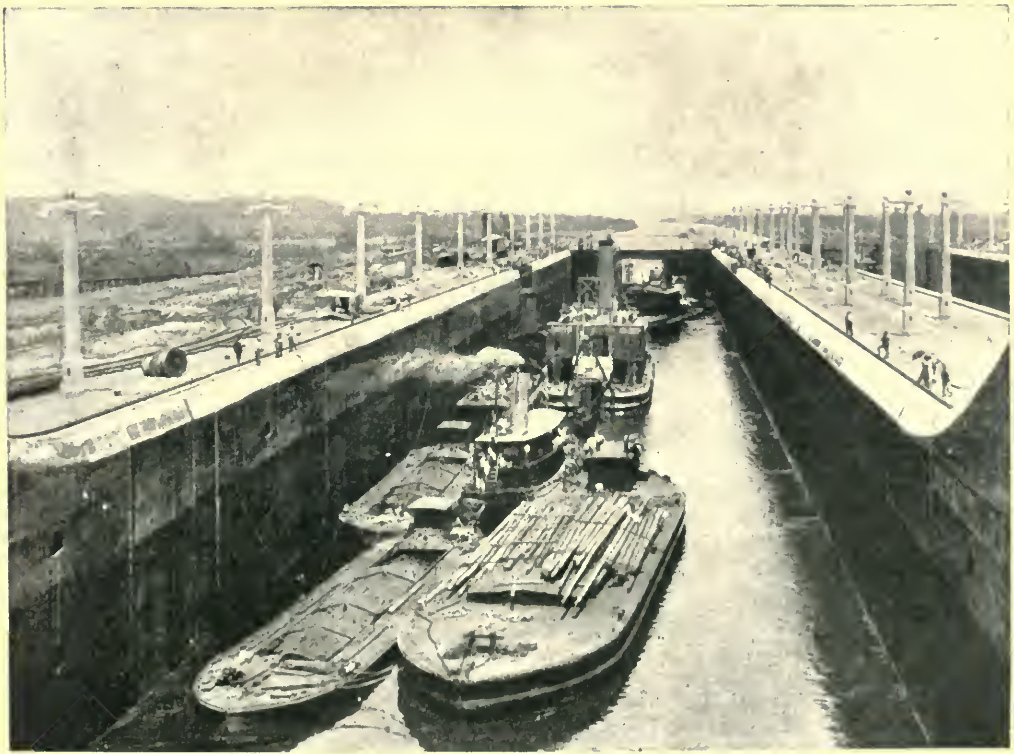
In 1908 Colonel Gorgas wrote: "It is now three years since a case of yellow fever has developed in the Isthmus, the last being in November, 1905." In New Orleans and the British West Indies similar successful campaigns have been waged against that dreadful disease. In 1909 it was completely banished from Rio Janeiro, where it had taken 30,000 lives in thirteen years. The world's death-rate is about 3 per cent. of the population. Whoever reduces that figure by one saves 1½ million lives every year. If every country where Anopheles and Stegomyia still hold sway were invaded by Dr. Gorgas and his staff, what a vast number of lives would be saved!

Though it was Colonel Gorgas who made the building of this great waterway possible, we must not forget that it was Colonel George W. Goethals and his able staff who accomplished this wonderful engineering feat.

IN AND OUT OF THE WORLD'S GREATEST LOCKS

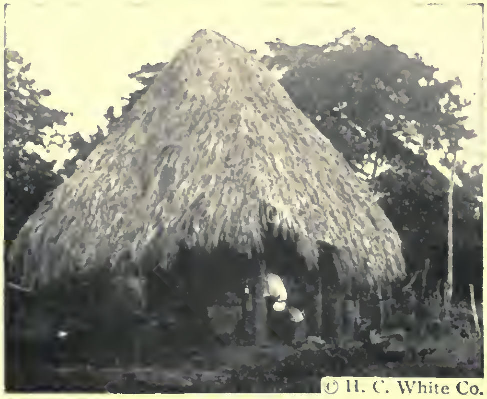


HOW THE SHIPS GO UPSTAIRS AND DOWN AGAIN—THE THREE FLIGHTS OF LOCKS AT GATUN THE ENGINES WHICH DRAW THE SHIPS THROUGH THE CANAL USE THESE TRACKS



THE LOCK THAT LIFTS A SHIP A THOUSAND FEET LONG AND A HUNDRED FEET WIDE—THE GATES OF THE LOCK ARE JUST CLOSING

LIFE & PEOPLE BETWEEN THE TWO OCEANS



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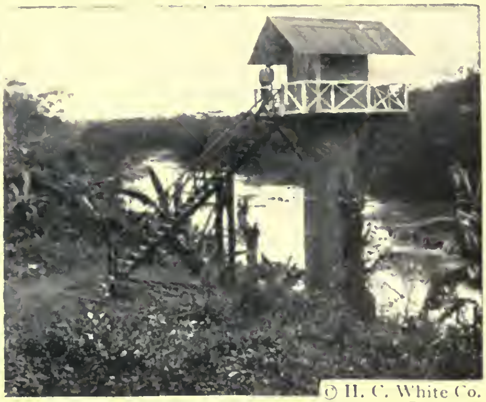
This is the kind of house the natives of Panama live in. Villages of this kind will soon give place to fine cities.



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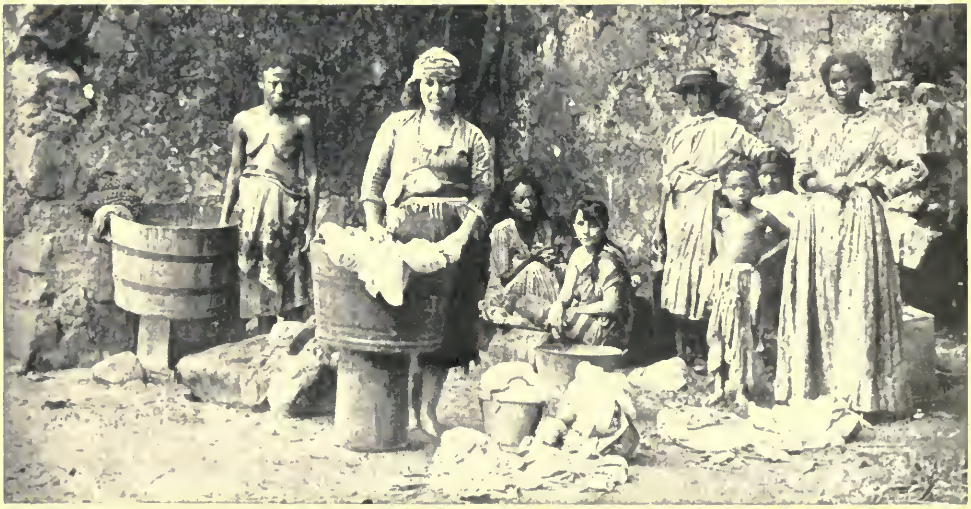
The curious watch-tower of an overseer on the Panama Canal works. Many of these look-outs were to be seen.



The natives of Panama are a mixed race, partly negro, partly Indian. Here we see a group of women whose homes are by the canal banks. They earned a very good living by washing the clothes of the thousands of workmen.

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At Panama, coal is taken to the steamers by negro women, who carry it in great baskets on their heads or shoulders.

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At some parts of the canal the women wash the clothes in the rivers, as seen here. The sight is very picturesque.

THE POWER OF FALLING WATER

THE MIGHT OF 8 MILLION HORSES DASHING OVER A CLIFF

FROM the earliest times men have used running water to do their work. In one of the pictures you see the great water-wheel on the Orontes River in Syria, built many centuries ago. This swiftly running water pushed the wheel around. As the wheel revolved it caught the water in buckets attached to it, and raised it to the aqueduct above, which carried the water to the city.

In another picture is a water-wheel of more recent times. The water in the stream pushed the water-wheel around, and it turned the machinery in the old mill. In early times water power was used in this way for grinding corn, sawing lumber, fulling cloth, and manufacturing iron goods. As New England had a great many waterfalls which furnished abundance of water power, it became the manufacturing centre of the country. But the mill or factory using the power had to be built beside the stream, and often these places were not easy to reach. However, because the power was cheap, manufacturers found it profitable to transport raw material from long distances to these points.

But man discovered a way of carrying the power of running water from the stream where it was made, hundreds of miles away to do work there.

This great discovery really depends on the work of Michael Faraday, an Englishman. Faraday found that you could start an electric current in a wire by having a moving magnet placed near it in a certain way. Therefore you need only a wire, a magnet, and power to make the magnet move, and you have an electric current. The water-wheel can turn the magnet, and the electric current can be sent over wires a great distance. Water power is being used more and more, for wherever waterfalls and rapid streams are found men use the power of running water to make electricity, and send it along wires to light cities, run railways, and to furnish power for factories and mills. Water power and electric power used to turn machinery are measured by a unit, called a horse-power, which is equal to the pulling power of one horse.

In Norway are great plants where electricity, generated by water power, is used to extract nitrogen from the air. Combined with other substances, it forms a valuable fertiliser. This is used to enrich the soil, when the nitrogen has been exhausted from it by many crops. In Switzerland the power obtained from many waterfalls is running the trains under the Alps. The famous Urfttalsperre Dam, in Germany, stores water which generates electric power for several cities. The large plant at Necaxa, Mexico, furnishes light and power for the City of Mexico and the mines of El Oro, 200 miles away. At Keokuk, Iowa, the entire flow of the Mississippi is used to

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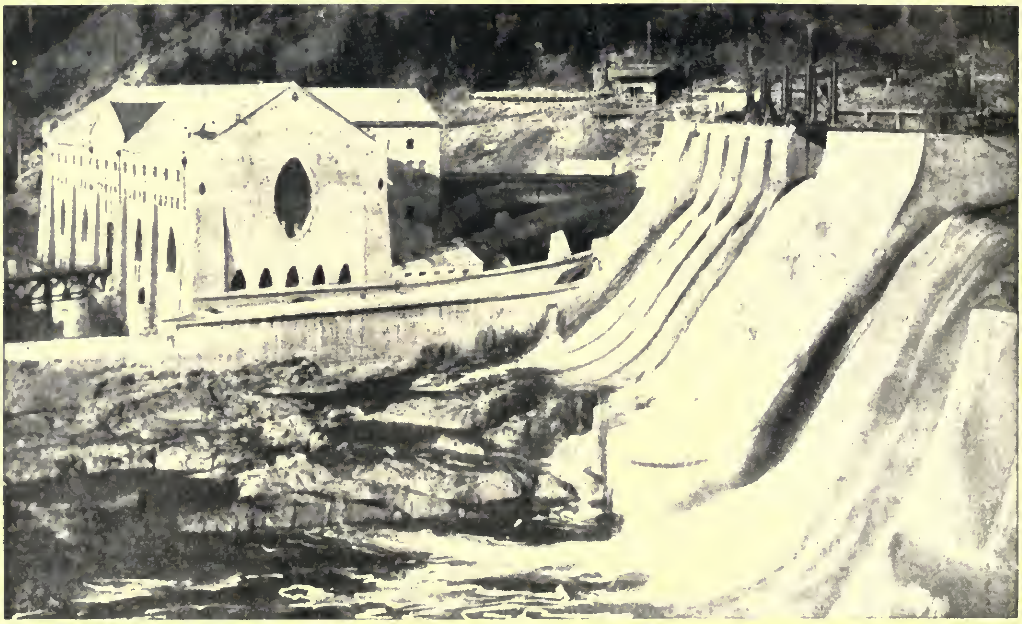
develop 300,000 horse-power, part of which is sent to St. Louis, a hundred miles away. In California, the electric power used by Los Angeles and San Francisco is carried over wires a distance of 240 miles from water powers in the mountains.

The most notable example in the world of the use to which falling water can be put is that of Niagara. Here for centuries a mighty volume of eight hundred million cubic feet of water has been falling over a precipice and running to waste every hour of every day and night. The mere weight of this water that falls in twenty-four hours is twenty-four million tons, but when we remember that it falls with a tremendous crash into a chasm 160 feet deep, we can easily understand that its force and the work it could accomplish are altogether beyond human comprehension.



ONE OF THE FINE POWER STATIONS NOW SPRINGING UP IN THE FOREST-CLAD MOUNTAINS OF NORWAY

If we put our finger under the water-tap and then turn on the tap, we find that the water presses with such force against the finger that it cannot be held in, but spurts out all round. What, then, must be the accumulated force of a mighty mass of water falling rapidly from a great height, as at Niagara?

Long ago, engineers realised that if only a fraction of the water of Niagara Falls could be harnessed they could be made to do a vast amount of work. It has been estimated by some experts that the power running to waste at the falls is equal to eight million horse-power, more than the power of all the coal mined in France and Belgium, if that were used in furnaces and turned into steam. This power is worth tens of millions of dollars a year, and yet, until recently, all that it has done has been to wear away a deep bed for the river in the solid rock.

The Niagara Falls were only discovered by white men in 1678, and it has been said that up to that time the roaring waters had been feared. Then they were admired, and now, at last, they are being used. As far back as 1725, a mill-wheel was set up on the edge of the falls to work a saw-mill, but it was not until 1890 that the first real water-power station was built for the making of electricity. This was a great success, and showed the world, to its astonishment, what could be done with falling water. From that time to this, rapid progress has been made. The greatest care is taken that the natural beauty of the falls shall not be spoilt. As a matter of fact, it is not the falls themselves that are used for getting power, but the water of the river above, about a mile before it reaches the falls. It is made to rush through a huge tunnel built of steel pipes—the largest water-pipes in the world—and it then falls down a penstock, or vertical pipe, measuring nearly forty feet round inside. The length of this pipe is 180 feet, and this gives the water an enormous power, which is used to revolve turbines—elaborate water-wheels made of steel. These wheels, in turn, work great electrical generators, and the electricity is then conveyed by wires to the cities all round the falls.

After revolving the turbines, the water runs away through another tunnel called a tail-race, which carries it below the falls, so that the water that has been imprisoned in the pipe meets the water which has fallen over the cliff. One of these tunnels is more than a mile and a quarter long, and took a thousand men three years to make. Three hundred thousand tons of rock had to be excavated, and the tunnel was then lined with sixteen million bricks. Visitors are able to go into this tunnel, which is nearly 160 feet below the bed of the river, and, from a gallery suspended from the roof, watch the water rush away.

The mouth of the tunnel is in the face of the rocky cliff over which the world-famed waters of Niagara crash with such a deafening, thundering noise as to make conversation in their neighbourhood almost impossible for visitors unused to the sound. There is thus a smaller torrent of rushing water, though tremendous in its way, bursting from the tunnel in the rock below the actual falls, and visitors may stand in the gallery suspended from the roof of the tunnel and see the Niagara Falls from the inside, as it were.

The waters rush over the precipice with such fury that they do not fall directly down the face of the cliff at all, but strike the river sixty feet or more from the rocky wall, the space between the falls and the rock being filled with a mass of whirling spray.

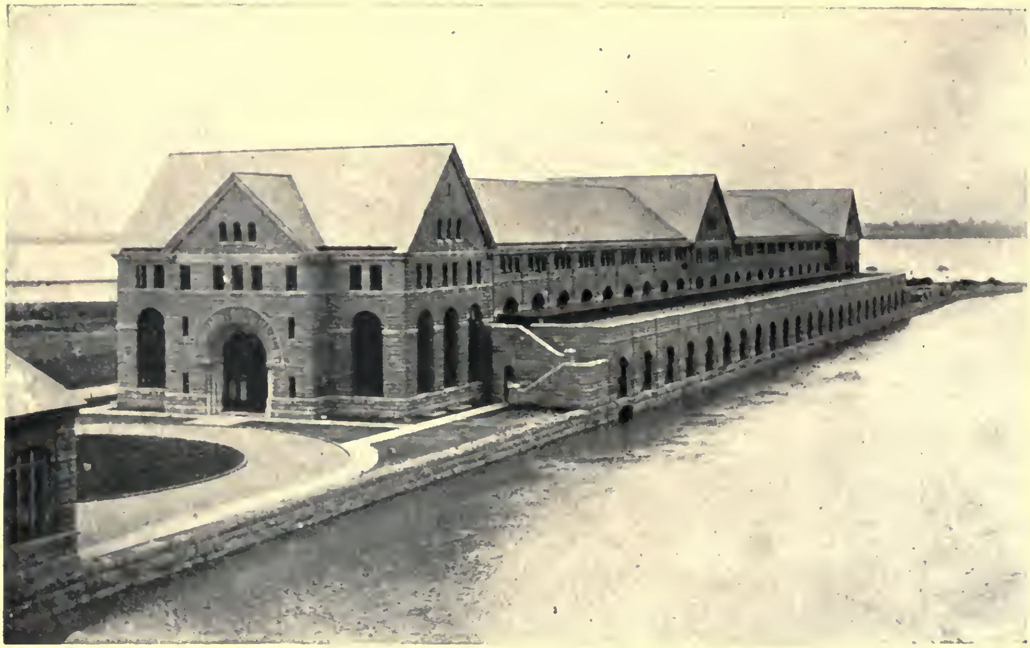
Just at the foot of the falls the water swirls round and round from the force of the cataract. From that point, however, the river flows quietly along, through a broad, deep gorge. Here a little steamer, called the Maid of the Mist, carries tourists back and forth to the foot of the falls. On this exciting trip the passengers must have rubber suits to protect them from the spray. About two miles down the gorge narrows abruptly, and the current quickens so that the river becomes a foaming mass of whirling water, called the Whirlpool Rapids. Below this the gorge becomes broader and deeper and makes a sudden turn. Here the whirlpool sweeps round and round and will suck down anything that comes within its deadly grasp. The cause of this whirlpool is a sharp turn in the river, which results in the rushing water being hurled against the Canadian side and then being flung back with a circular motion.

A WHEEL-PIT AT NIAGARA

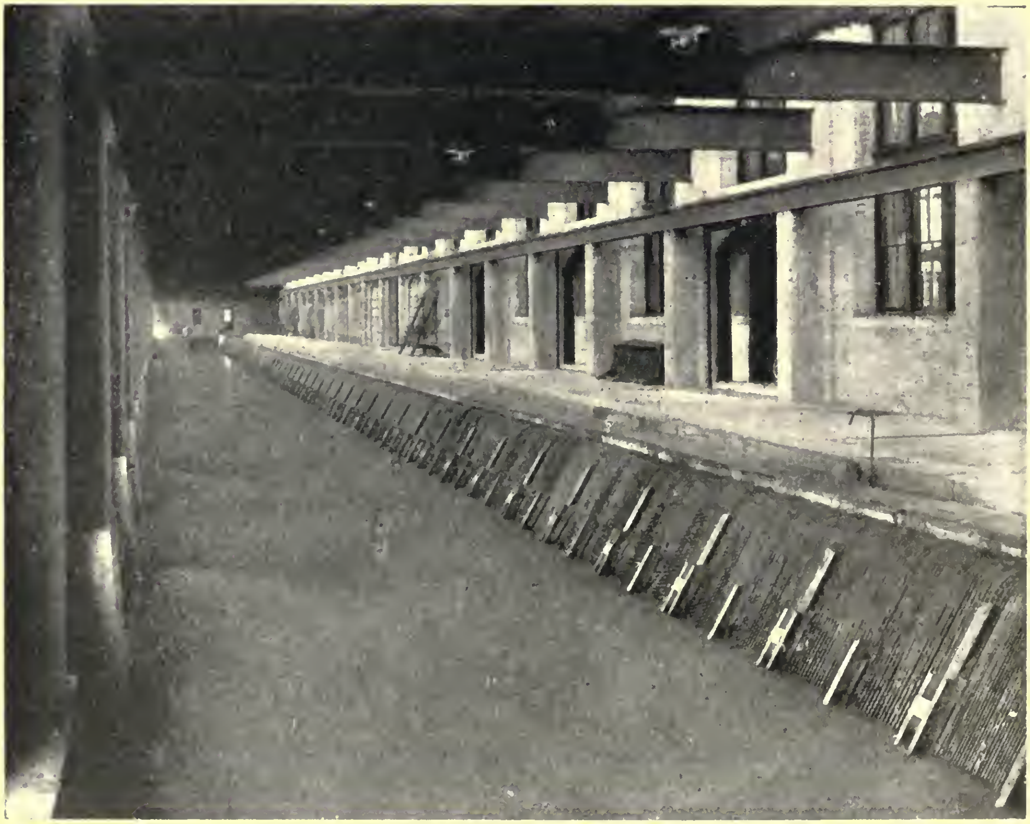
The water that turns the turbines falls down great upright pipes built within the walls of these pits.

When all the power-stations now being built are in full working order, the power captured from the falls will be about equal to that of a million horses, and will supply to cities three hundred miles away enough electricity to run all their machinery and street cars, and to light the streets and houses. Already, Syracuse in the East and Windsor in the West, cities 400 miles apart, are supplied with power from Niagara. On the American side of the falls there are great manufacturing cities, like Buffalo, where, although coal is very cheap, being only two or three dollars a ton, it is never used for steam power, because all the power for factories and street cars, for lighting, and all other purposes, can be obtained much cheaper from the Niagara power-stations twenty-three miles away.

CAPTURING PART OF A GREAT RIVER

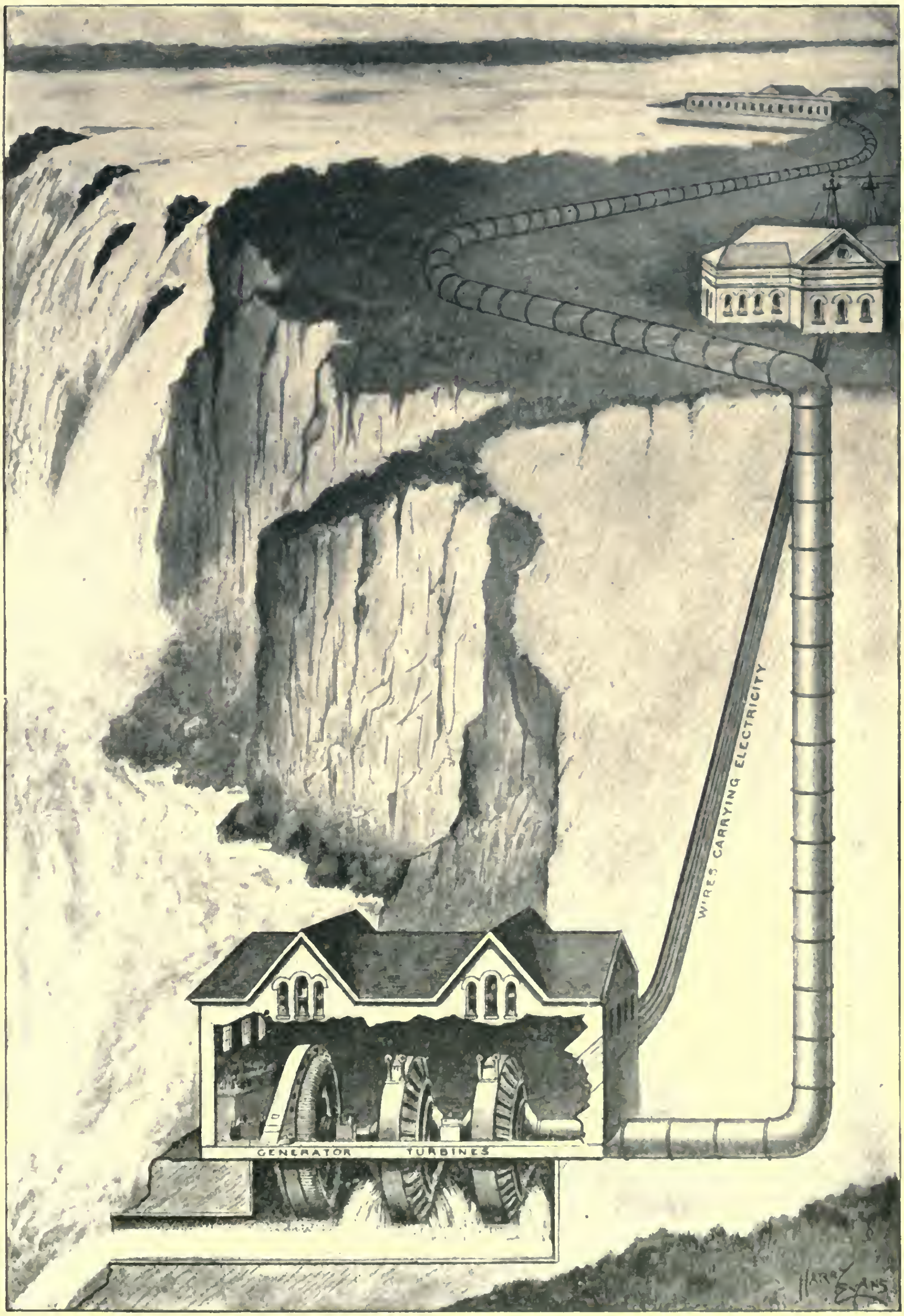


The harnessing of Niagara Falls is perhaps the most wonderful engineering feat accomplished by the genius of man A power-house like that shown in this picture is built some distance above the falls, and water is drawn from the river.



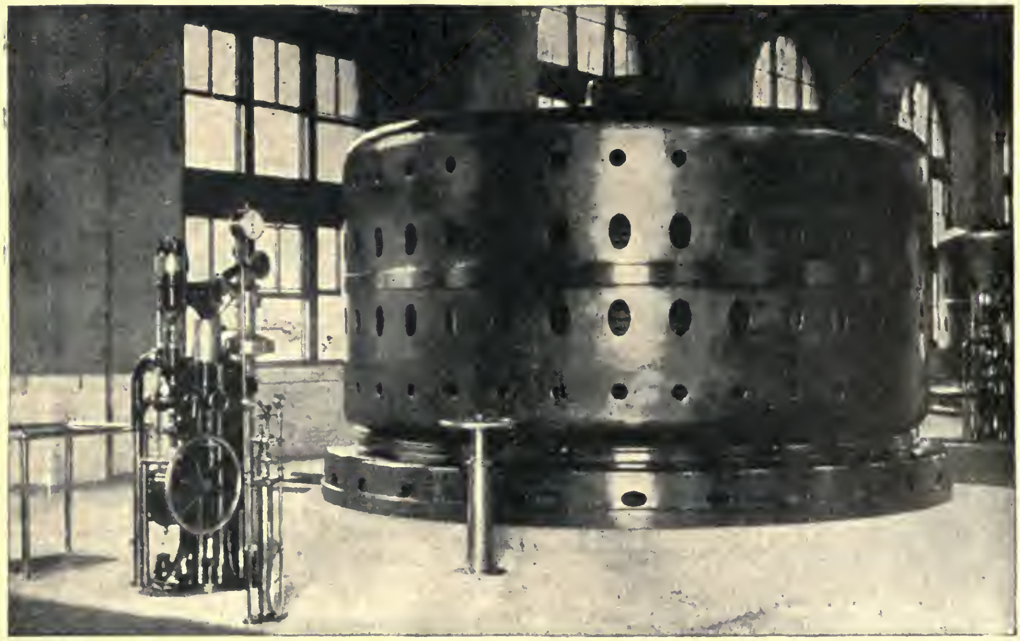
From artificial channels the water passes into an artificial bay, such as is shown here. Any ice that may be floating in the river is kept from entering by gratings, through which all the water must pass. The water is then diverted into penstocks, or huge vertical pipes, down which it falls with terrific force. Part of the falls are thus imprisoned in these pipes.

HOW NIAGARA SENDS LIGHT FOR 300 MILES

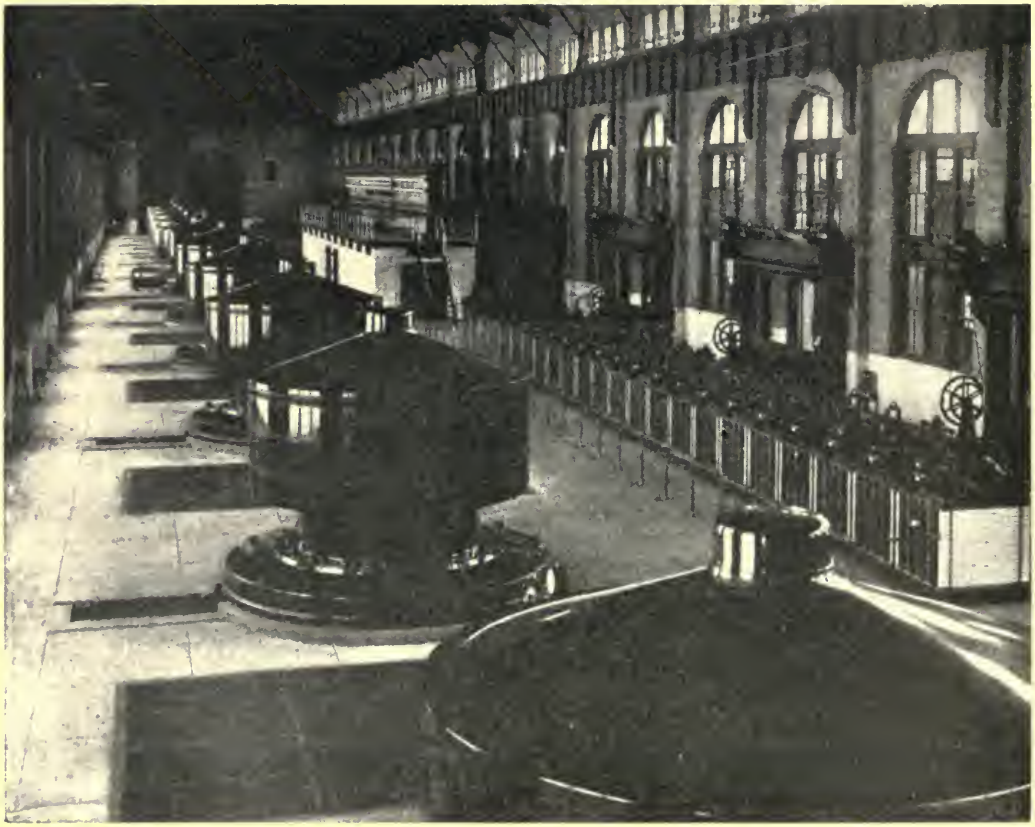


We can see at a glance, in this picture, how Niagara Falls are harnessed. A great wall is built out into the river to divert part of the water to what is called the forebay. From here the water passes into the penstock, the huge pipe through which it falls 150 feet with terrific force, turning the turbines at the bottom. The turbines, in their turn, revolve the generator, which generates the electricity The current is carried by wires to the distributing station above, and sent from there to light cities, drive cars, and work the machinery of great factories over an area of hundreds of square miles,

A HUNDRED TONS OF STEEL SPIN ROUND

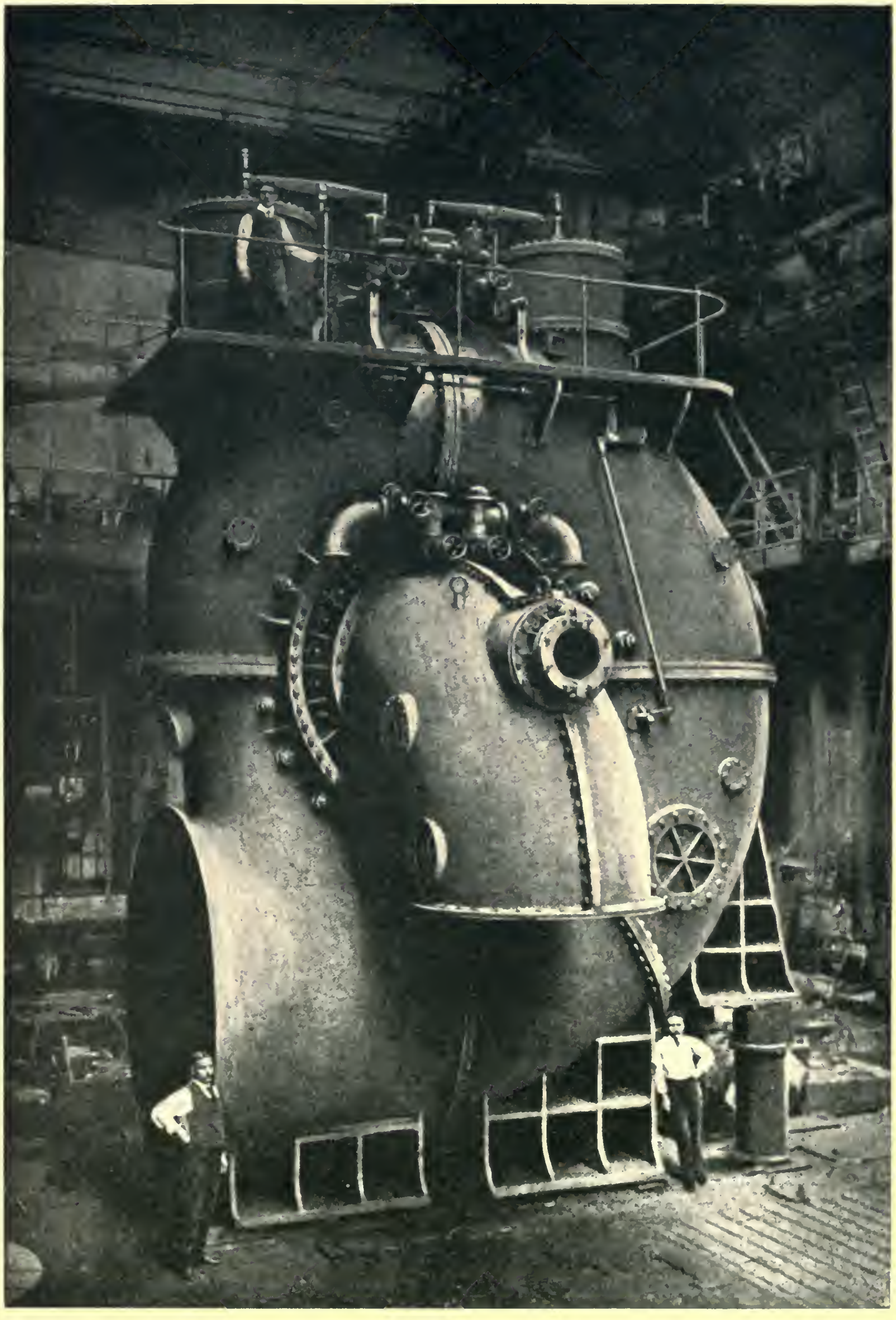


This great generator, worked by one of the Niagara turbines, generates electricity equal to ten thousand horse-power, and even more powerful machines are now being erected. The whole of the immense power which these wonderful machines gather from Niagara Falls can be controlled quite easily by the switchboard seen in the bottom picture.



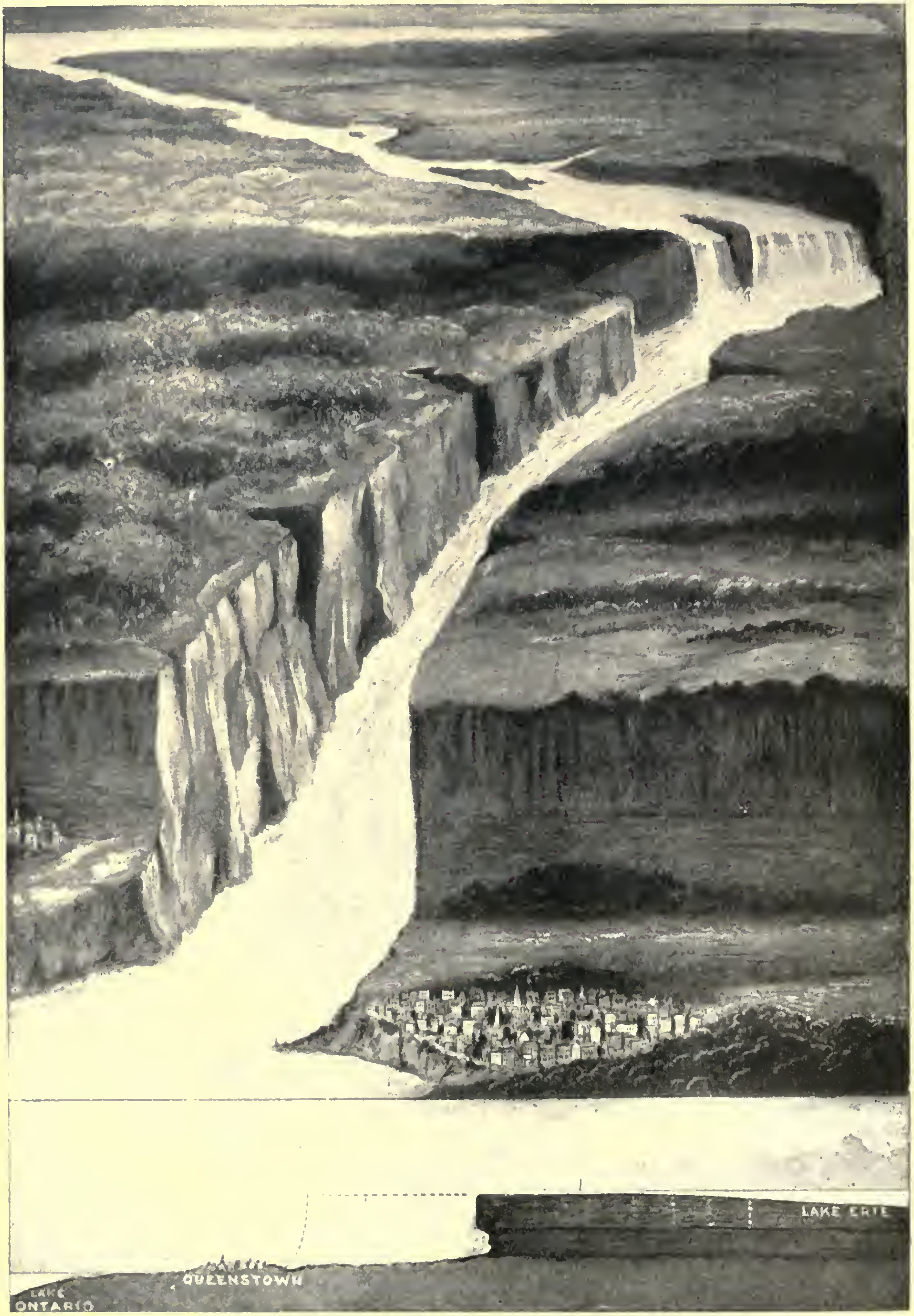
Here is one of the great power-houses at Niagara. The curious-looking circular objects are electric generators, revolved by the turbines, or water-wheels, working at the bottom of pits 180 feet deep. The switchboard is at the end of the room.

THE GIGANTIC WHEEL TURNED BY NIAGARA



This picture, showing the outside of a turbine, gives some idea of the tremendous size of these marvellous steel water-wheels. The wheel that revolves inside this will generate enough electricity to light a town, and the entire turbine weighs 180 tons. To turn the wheel, 24 million gallons of water pass through the casing every hour, enough to form a wide river.

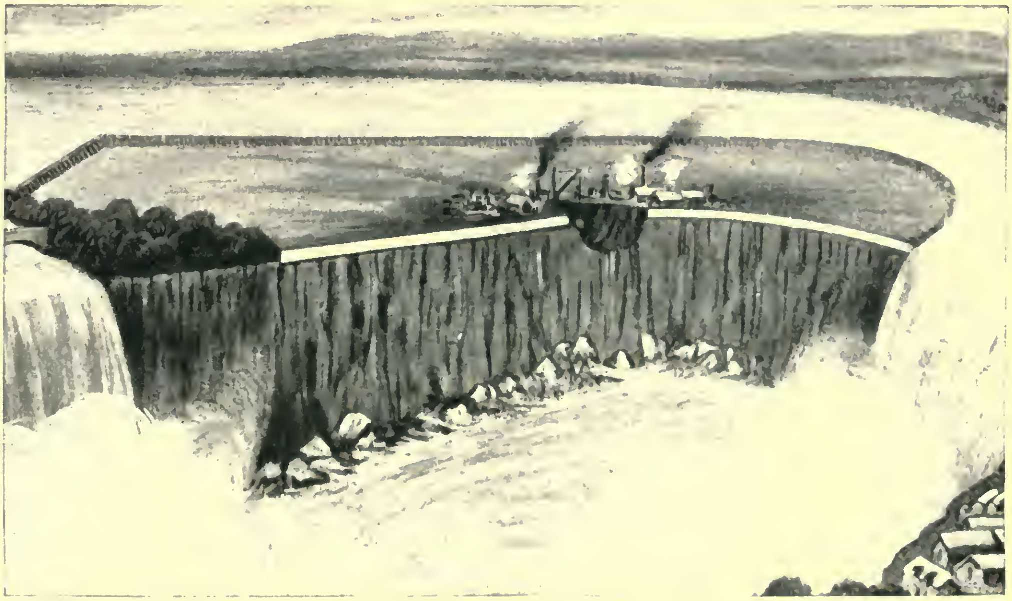
THE CREEPING BACK OF NIAGARA FALLS



When we think of Niagara Falls, we picture them as always having been there, but the falls are, year by year, creeping farther back. For thousands of years the Niagara river has been cutting out for itself an ever-deepening channel, and it now rushes through a vast chasm, as shown in the top picture, crashing at last over a precipice. The dotted line in the lower picture shows where the falls used to be, and we see how, as the cliff wears away, the level of Lake Erie gets lower.

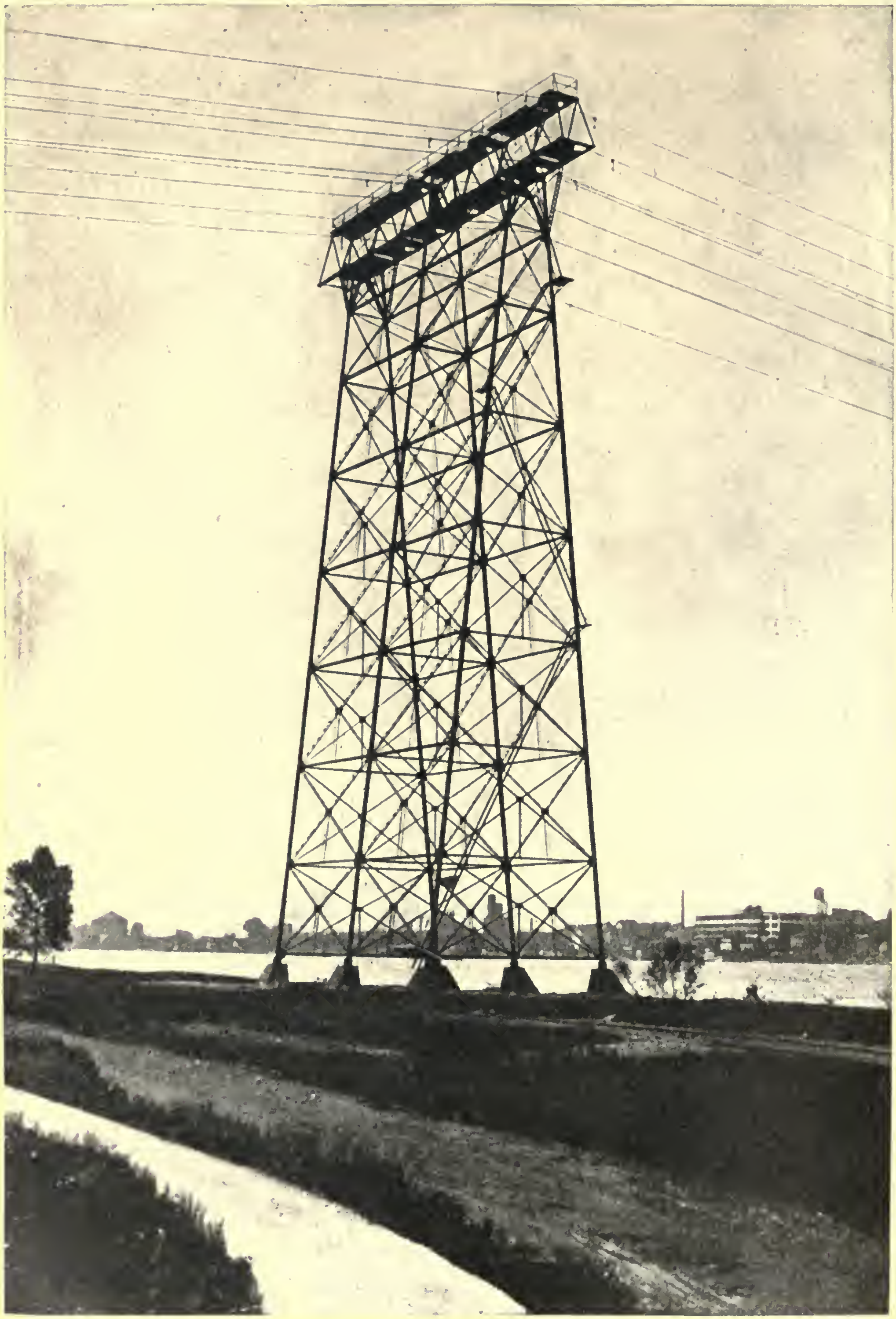
WILL THE FALLS ONE DAY DISAPPEAR?

It is only in recent years that men have begun to harness the pent-up energy of these mighty falls for useful purposes. The water crashes over the cliff, as seen here, with a force equal to eight million horse-power. But will the falls ever disappear?



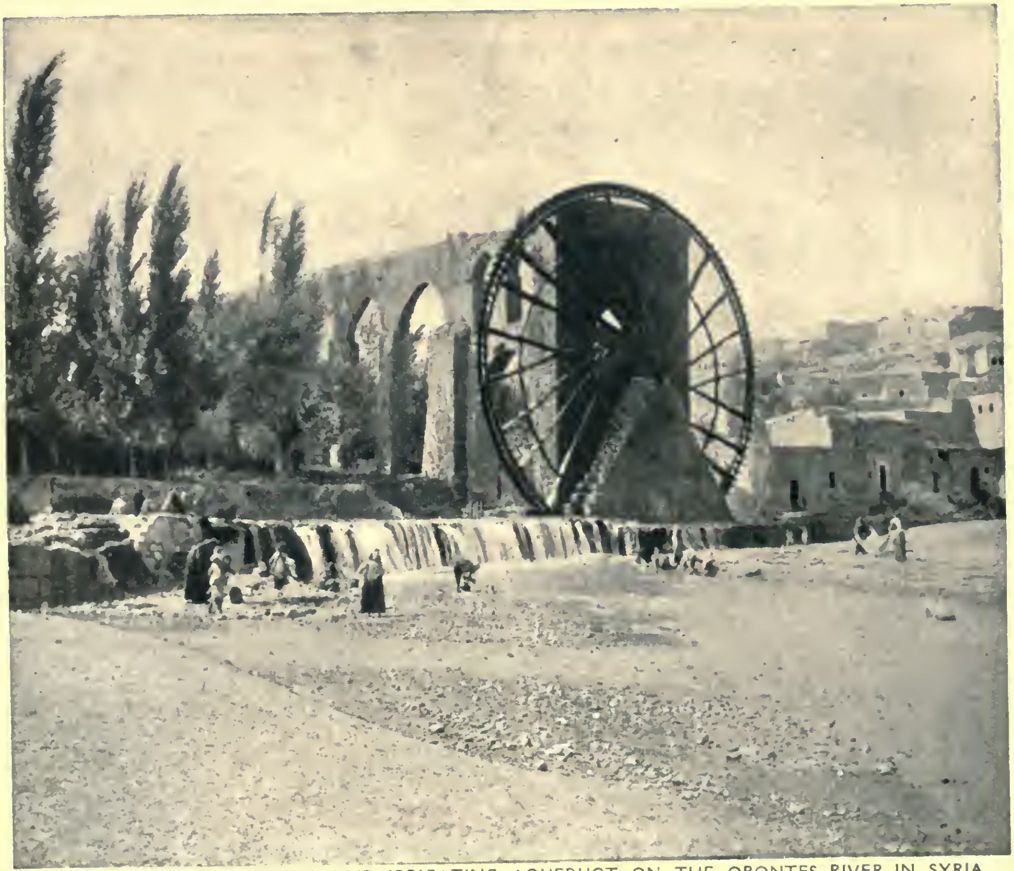
Every year the falls of Niagara are wearing away, and the edge of the cliff has been eaten into, as this picture shows. A proposal has therefore been made to stop this by turning the course of the river for a time, and building along the edge of the cliff, as shown here, a strong steel facing to resist the water. It is suggested that the great hole which the water has eaten out of the cliff could be filled up with cement, strengthened by a frame of steel, and further damage thus prevented.

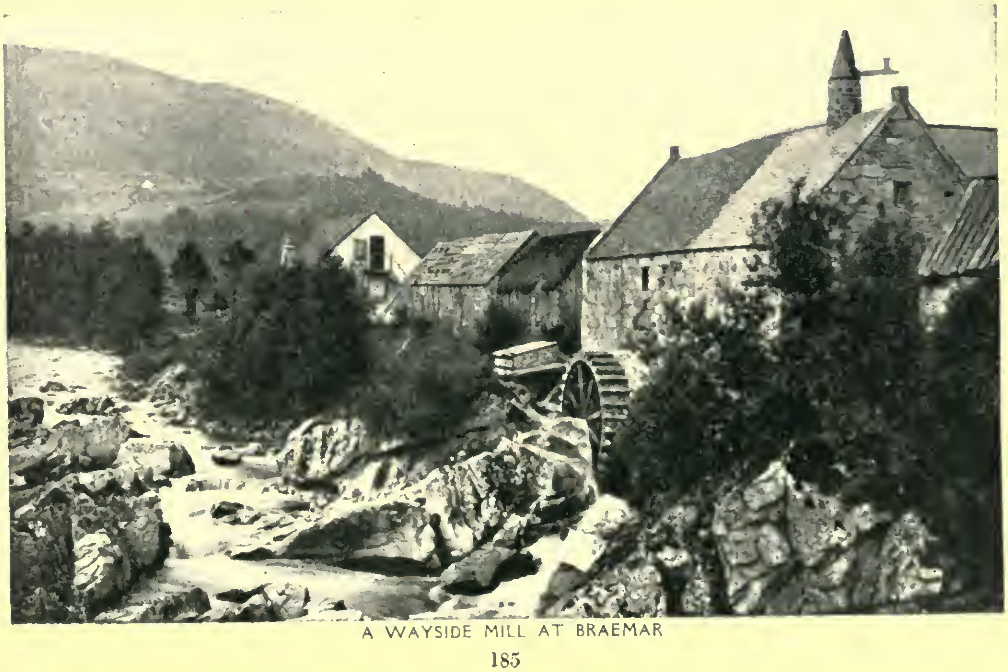
THE TOWER BRINGING POWER FROM NIAGARA



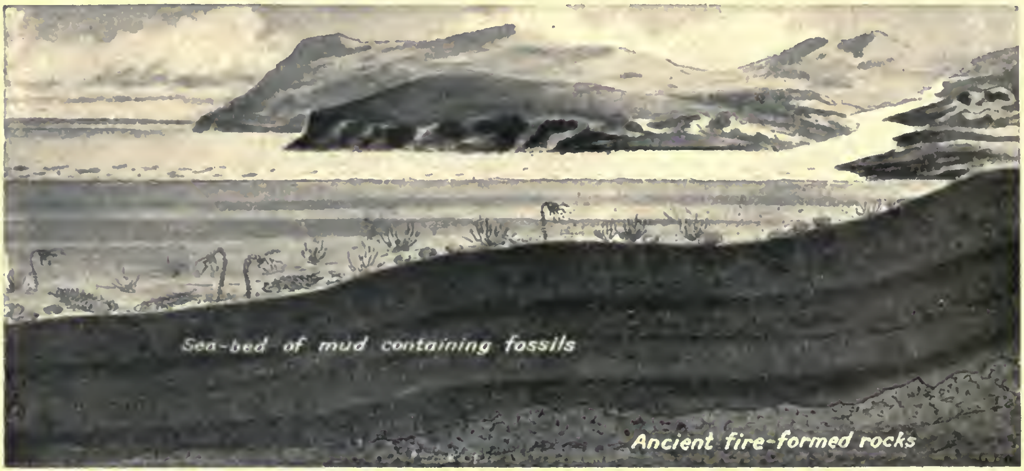
The wires which distribute the electricity generated by the turbines are carried to the cities and towns on high steel towers. The tower shown in this picture is over two hundred feet high. The wires to Toronto, 88 miles away, run over a private road 80 feet wide. On this road an electric railroad may be built which will carry cars at a very high rate of speed.

THE OLD WAY OF USING WATER-POWER

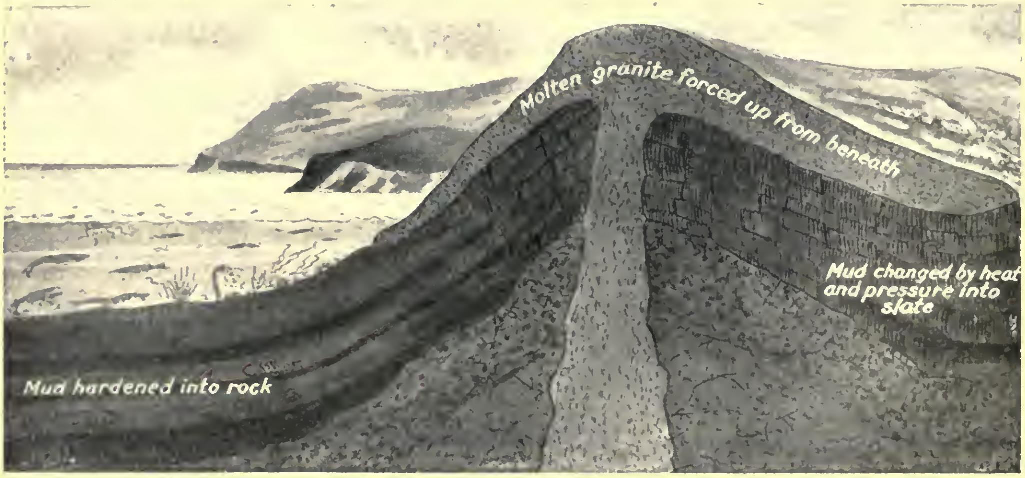

THE GREAT WATER WHEEL AND IRRIGATING AQUEDUCT ON THE ORONTES RIVER IN SYRIA


A WAYSIDE MILL AT BRAEMAR

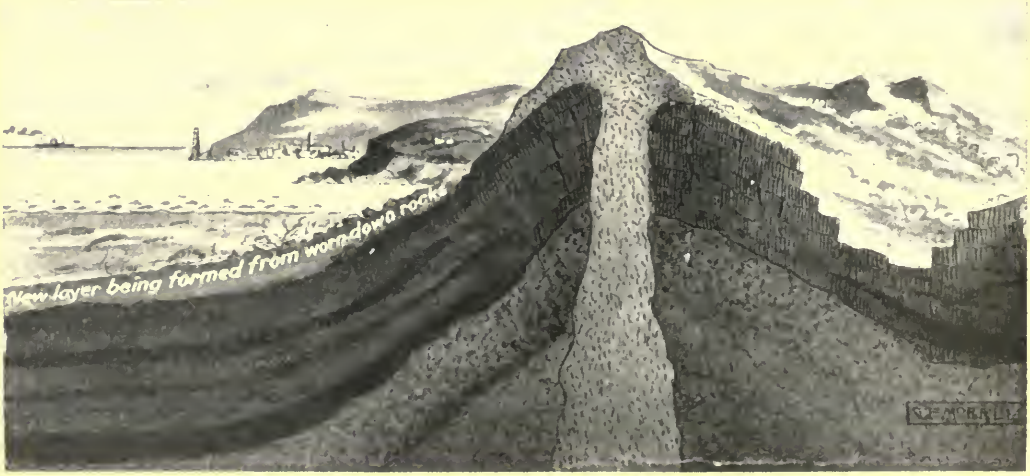
HOW A SCHOOL SLATE CAME OUT OF THE SEA


Sea-bed of mud containing fossils
Ancient fire-formed rocks

Millions of Years Ago. An imaginative picture of the world when the earliest forms of life existed in the sea, showing the sediment brought down from the mountains and deposited as mud in the sea-bed, gradually forming a layer thousands of feet deep


Molten granite forced up from beneath
Mud changed by heat and pressure into slate
Mud hardened into rock

Millions of Years After. During thousands of years an immense fold of the earth's crust formed and split, so that masses of molten rock welled up from below, flowing over the solid strata of mud. As the result of the great heat and the great weight the mud now formed into slate, and the tremendous stress and strain caused the cleavage that is so characteristic of slate masses.


New layer being formed from worndown rocks

In the Present Day. After the passing of millions of years more, the great fold of the earth's crust has become a granite mountain partly worn away, leaving the slate exposed in places. The wearing down of the hills brings fresh deposits to the sea-bed, which is slowly rising, and the general effect of the processes by which land and sea change place is clearly seen in the landscape.

THE WRITING ON THE BLACKBOARD

THE BIT OF MOUNTAIN THAT HANGS ON THE SCHOOL WALL

THE boys and girls who have a blackboard in their schoolroom are so busy with the number work and the copy written on it that they have no time to even wonder where the blackboard came from. But if they had stopped to wonder about it they would have been interested and surprised. Who would dream that that smooth, clean gray surface was once mud? Yes, mud. It does not seem possible, but it is true. The blackboard is made of slate and the slate was once mud in the bottom of the sea, and the interesting part is how the mud became slate.

HOW SLATE WAS MADE OUT OF MUD

Millions and millions of years ago there was a mighty mountain, and for millions of years its summit was washed by rain and mist, so that streams trickled down it and became first rivulets and then rivers. And as the streams and rivers and rivulets trickled down, they cut first little channels, and then deep river-beds, and then great valleys, and evermore wore down the rocky mountain, and carried bits of it, crushing and grinding them as they went, until they were carried as mud to the sea. This mud sank to the bottom of the sea and became clay. For thousands and thousands of years this went on, and the mountain became more and more worn away, and in time there was a tremendous amount of sticky mud in the bottom of the sea. Starfish were born and died, and shellfish were born and died, and when they died they fell into the mud and were covered up and buried, and still the mud poured into the sea. This mud of the mountain contained many things, — silica, aluminum, iron, potassium, sodium, lime and shells, and all this collected at the bottom of the sea for thousands and thousands of years. All this time the earth was cooling, and as the earth cooled it shrunk, and the result was that the mud in the bottom of the ocean was squeezed together very hard, and in the end it was squeezed so hard that it began to bulge out of the ocean in great masses which grew into mighty mountains of slate. It was squeezed and squeezed so hard and tight that the mud split into layers and that is why slate is so thin and can be split so easily.

THE SLATES THAT OUR GRANDMOTHERS USED

This peculiar hardened mud is used for many things beside blackboards. Once upon a time it was used in the schoolroom in a different way. Mothers and fathers and grandmothers and grandfathers could tell about it. It was in the days when there were little red schoolhouses standing near the four corners of a country road. The boys and girls who came to this school did not have attractive school bags or pencil boxes or neat blank books and writing tablets, or reading books with coloured pictures. But one thing they did have that the boys and girls of to-day can not boast of. That was a slate. As the name indicates, this important part of the scholar's outfit was a piece of slate bound with a wooden frame about an inch wide. On this slate were done all the sums, all the writing lessons and drawing lessons; in fact, everything that is done with pencil and paper in the schoolroom of the present day.

But the slate was of no use unless there was something with which to mark on it. A lead pencil would not make a mark that would show on slate, so in place of that a pencil of slate a little smaller than a lead pencil was used. Slate against slate produces a squeak and a scratch, so that the quiet of the schoolroom was often broken by the squeak, squeak of the slate pencil on the slate. The slate could be used over and over again, after the work had been erased and the slate cleaned. For this purpose, the neat little girl had a small bottle of water, and a sponge tied to her slate, which she used in the process of cleaning. But the boy scorned such a girlish performance and his manner of erasure was a much simpler and a quicker process. He spat upon the slate and rubbed out all traces of his work with the sleeve of his coat. It can be seen why the slate and the slate pencils are no longer used in this age of sanitary conditions.

SLATE IS USEFUL FOR MANY THINGS

Let us take into account some of the many ways that slate may be used in a house in which we live. It is used for

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roofing in place of the wooden shingles and it is especially suited for this purpose because it possesses all the qualities necessary for protection against wind, rain, and snow; it is used for chimney pieces, for kitchen sinks, for bathroom and laundry floors, for wall linings, for interior decoration, for cisterns and for washtubs. Around the house there may be a slate walk and in front of it a slate road. If there is a billiard room in the house the billiard table top is made of a huge piece of very smooth slate.

The switchboards that handle the electric current in the great subways of New York and other cities, and the switchboards of the many telephone exchanges throughout the country are made of slate. Only the very best grade is employed for this important work and much care is taken in the choice.

WHERE SLATE COMES FROM

Where does all this slate come from? If it is put to so many different uses the supply must be large, almost inexhaustible. It does not look as if the supply would give out, for it is found in large quantities in Vermont, Pennsylvania, Maine, New York, Georgia and several states of this country in the island of Newfoundland, and also in large amounts in different parts of England and Wales. In the latter country it is so abundant that it has been said that the Welshman takes to the slate quarries as the fish does to the water.

Off the coast of Argyllshire in Scotland there is a little group of five small islands called Slate Islands, because they are composed almost entirely of slate. The quarries on these islands have been worked for nearly three hundred years, and millions of slates are taken out every year.

HOW SLATE IS QUARRIED

To obtain the slate sometimes shafts are sunk as in coal pits, but more often it is quarried by blasting, and by the use of channeling machines like those used in quarrying marble. By means of these channeling machines a series of cuts are made in the rock at right angles to each other and the block is broken off by means of wedges, or powder. After the blasting, the men sort out all the good blocks and send them to the slate huts on the mountain near by, where they are split and dressed into slates by means of hammer and chisel. Slate splits best when it is "green," that is, when it is first taken from the quarry.

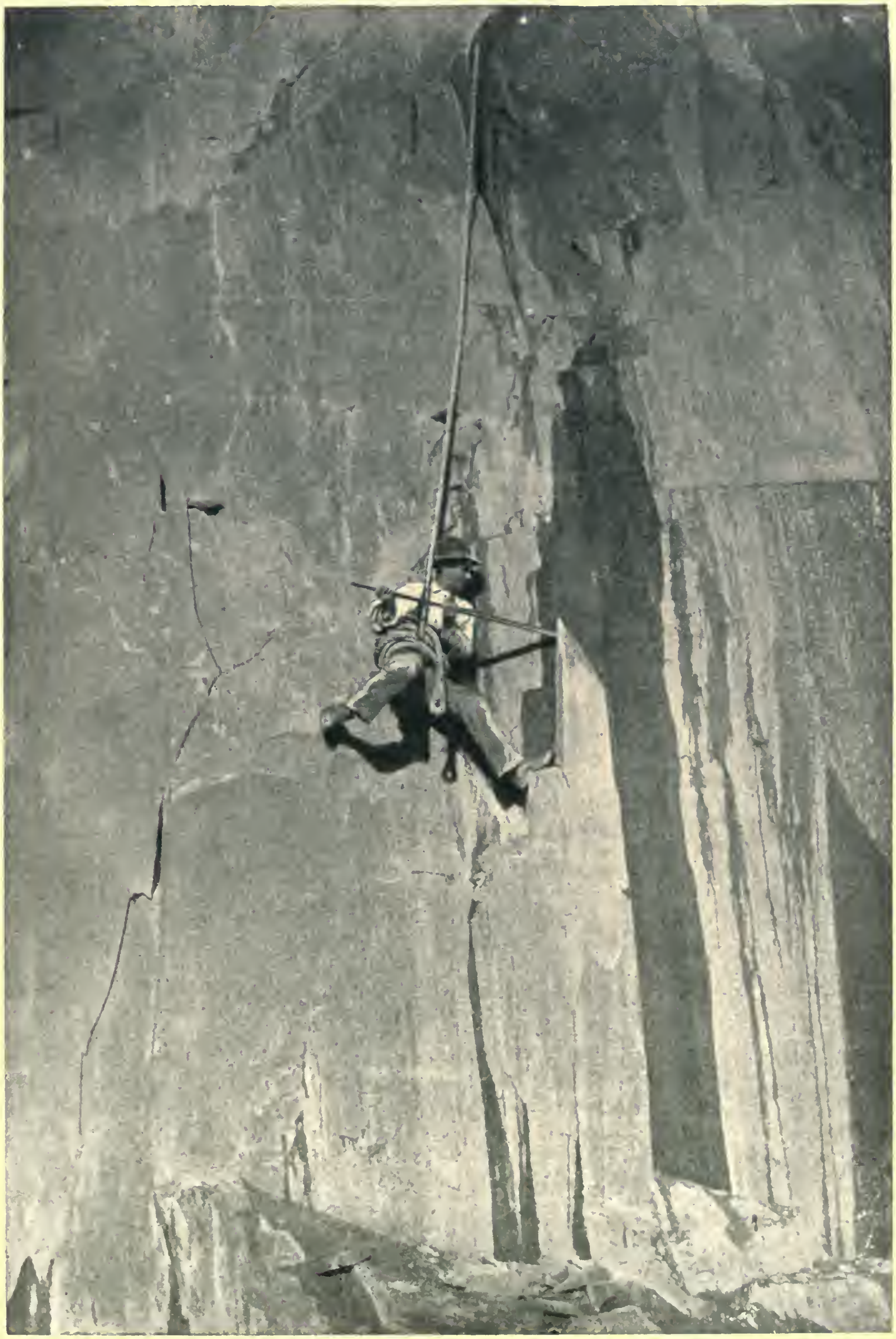
DANGER IN QUARRYING

The blasting of slate is a very dangerous performance as well as a very difficult and expensive one. Not long ago, when 150,000 tons of slate were to be blasted, no less than three months were occupied in making the preparations. Three tunnels were cut at the base of the mountain and ten chambers, or little caves, were made in the rock for the explosives or charges. Then these ten chambers were filled in with stones and cemented, so that the charge would not blow out, and twenty-minute fuses were attached to the charges, in order that the workmen would have twenty minutes to get to a place of safety before the explosion took place. Just a few seconds before the explosion the earth shook for a mile around as if there were an earthquake; then the wall of slate split open in all directions, and fell in a heap. Sometimes the engineers and workmen, after placing the charge, jump on to a small locomotive that has been provided to take them to the top of the quarry out of all danger from the blasting.

There is such a decided slant to the slate vein that disasters often occur, and if, when the earth was "made over" the last time, the slate walls had been left perpendicular instead of slanting, much trouble would have been saved. As it is the slant makes an over-hanging wall which sooner or later falls over into the pit below, and avalanches of stone and earth continually haunt the minds of the workmen.

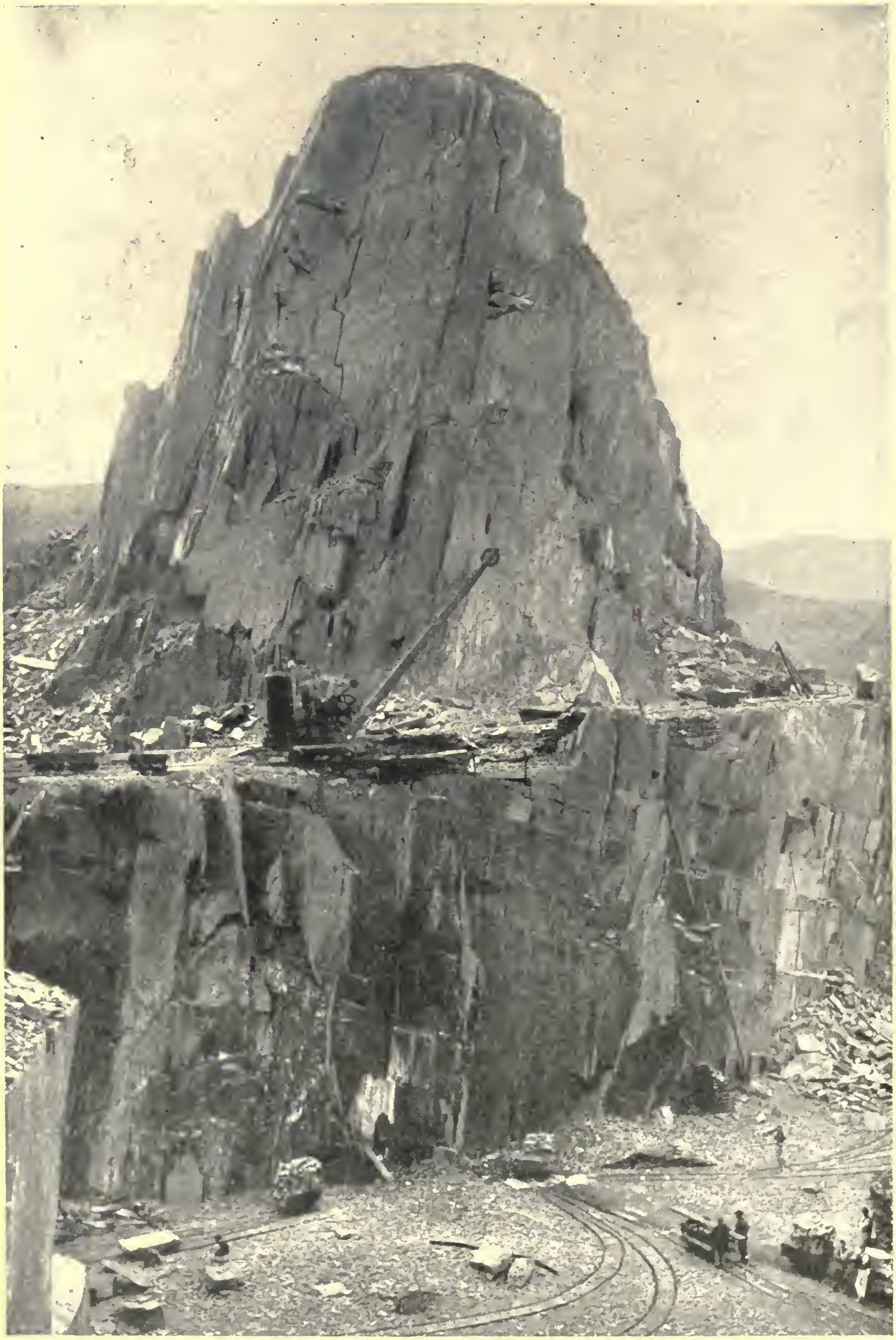
Beauty was not Mother Nature's aim certainly when she created these slanting walls of slate and stone, for they are very ugly and spoil many an attractive spot. But we can forgive this defect because of the great service these ugly walls have done the world from the time of the unclean slates to the day of switchboards in the great subways. The appearance has improved in the past millions and millions of years, at any rate, for once these walls were only dirty, black mud in the bottom of the sea.

HOW SOME MEN WORK FOR DAILY BREAD



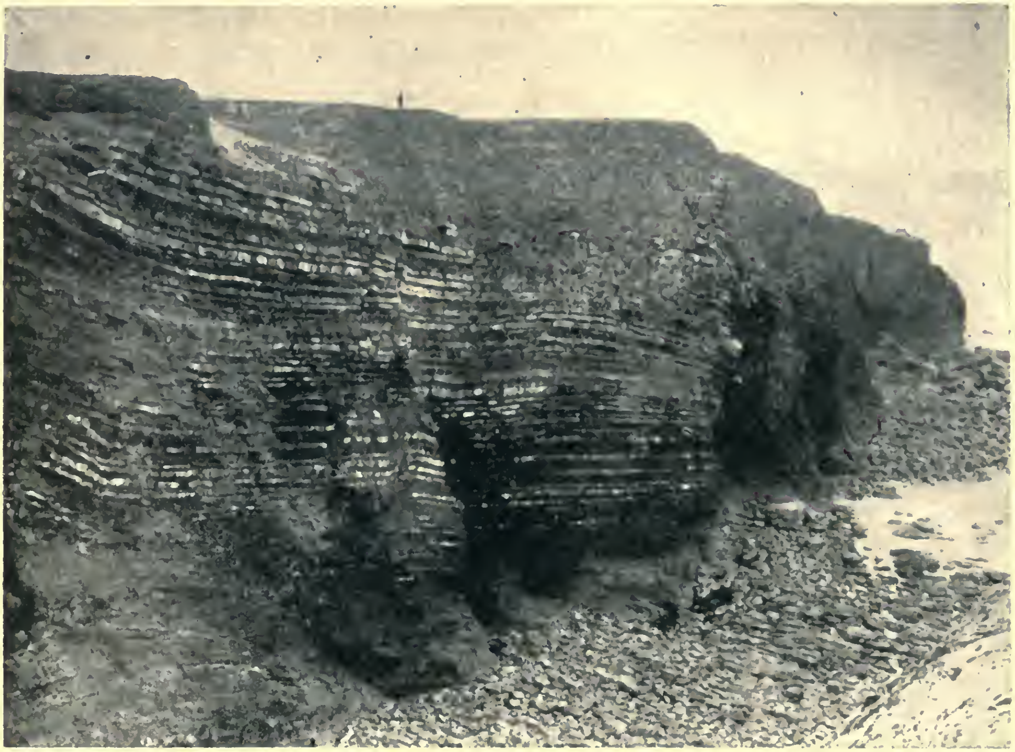
HANGING FROM THE TOP OF A PRECIPICE, TO BREAK AWAY THE SLATE LOOSENED BY BLASTING

A GREAT PLATFORM ON A MOUNTAIN SIDE

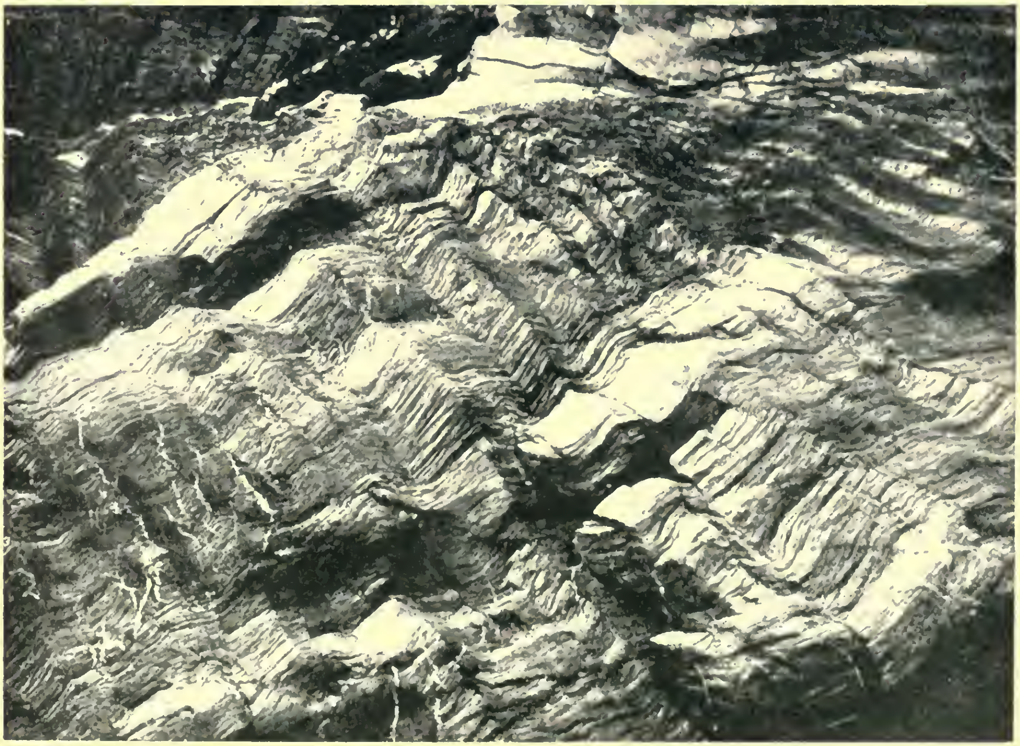


ONE OF A SERIES OF GALLERIES, OR PLATFORMS, CUT INTO THE FACE OF THE ELIDIR MOUNTAIN, NORTH WALES. EACH "GALLERY" IS 75 FEET DEEP AND TOGETHER THEY RISE 1800 FEET FROM THE GROUND

NATURE'S OWN PICTURES OF THE MAKING OF THE EARTH



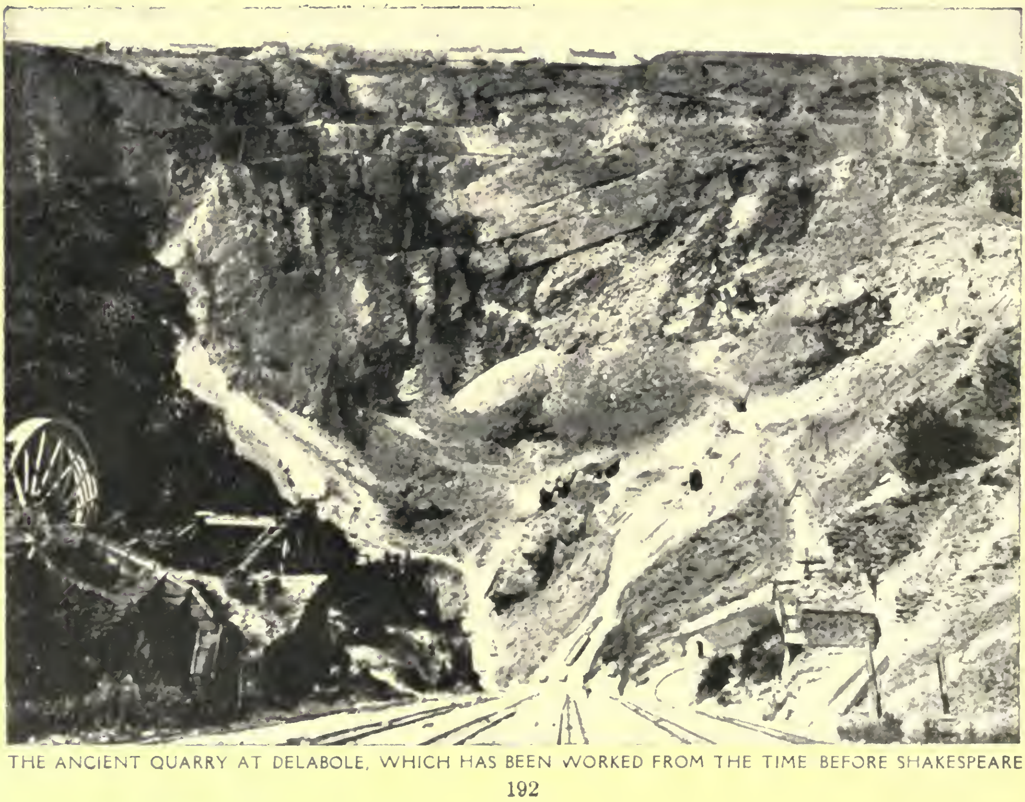
LIMESTONE, FROM LIVING CREATURES, AND SLATE, FROM SEA-SAND, LYING IN ROWS ONE ABOVE THE OTHER, AS FORMED IN THE SEA DURING AGES PAST—THE MARBLE CLIFFS AT PORTHMISSEN, CORNWALL



A GREAT MASS OF SLATE ROCK WHICH WAS ONCE HORIZONTAL BUT BECAME PUCKERED BY PRESSURE DURING THE SHRINKING OF THE EARTH

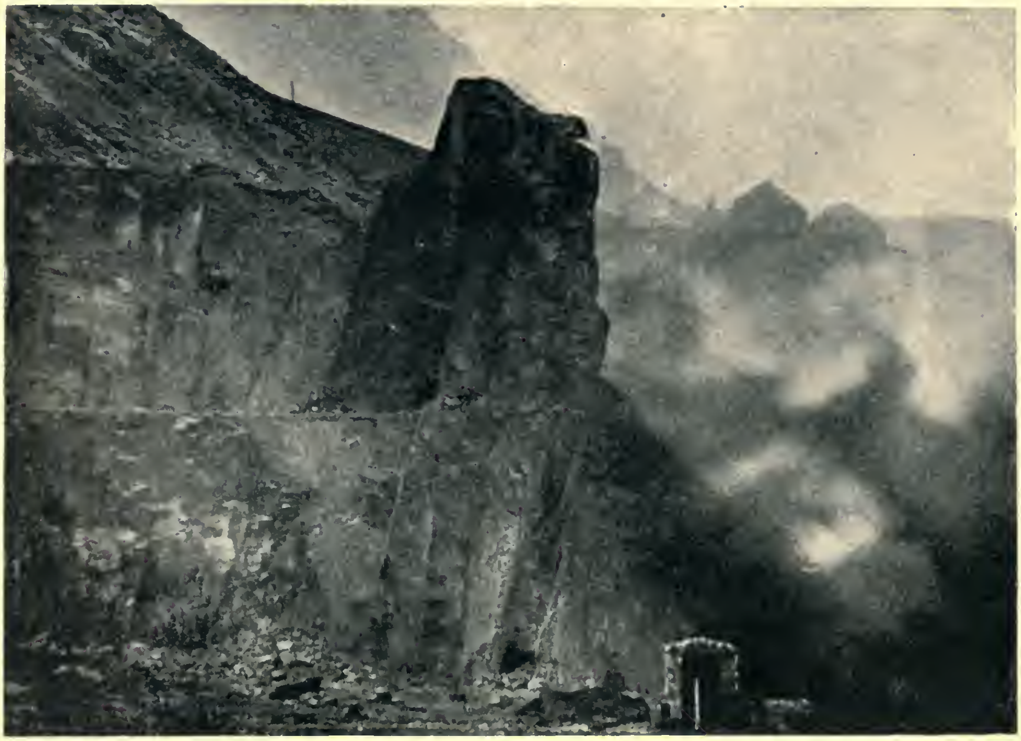
WHERE SHAKESPEARE'S SLATE MAY HAVE COME FROM

THE OLD, OLD QUARRY THAT MIGHT HAVE GIVEN SHAKESPEARE A SLATE—AT DELABOLE, CORNWALL

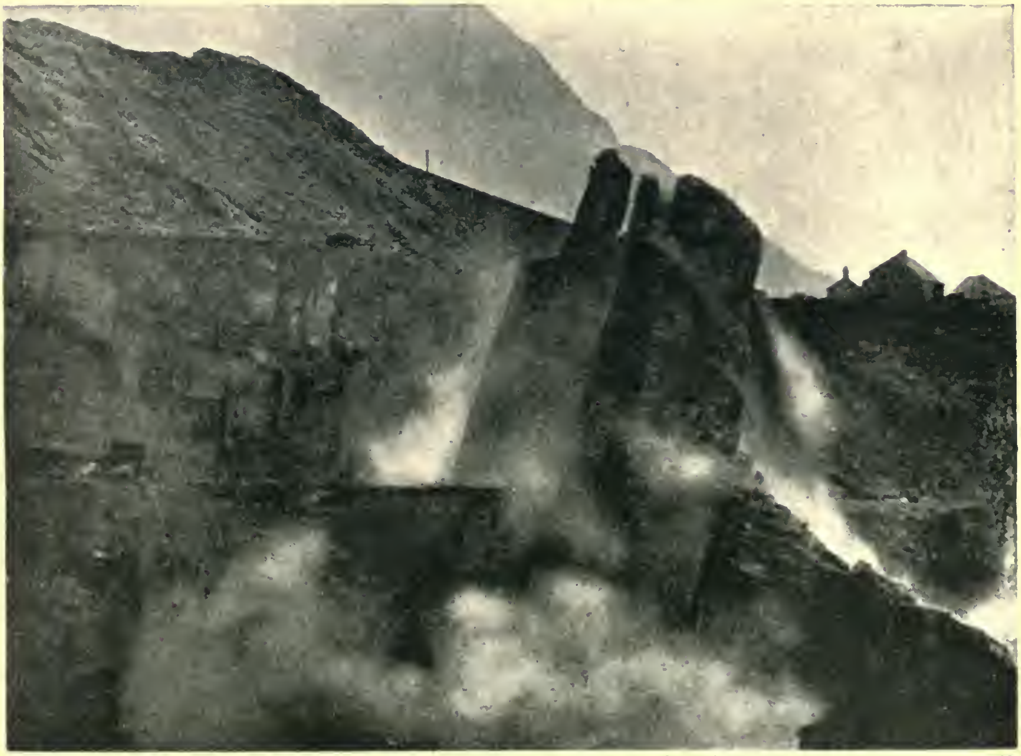


THE ANCIENT QUARRY AT DELABOLE, WHICH HAS BEEN WORKED FROM THE TIME BEFORE SHAKESPEARE

THE SIGHT OF AGES PASSES FROM MEN'S EYES

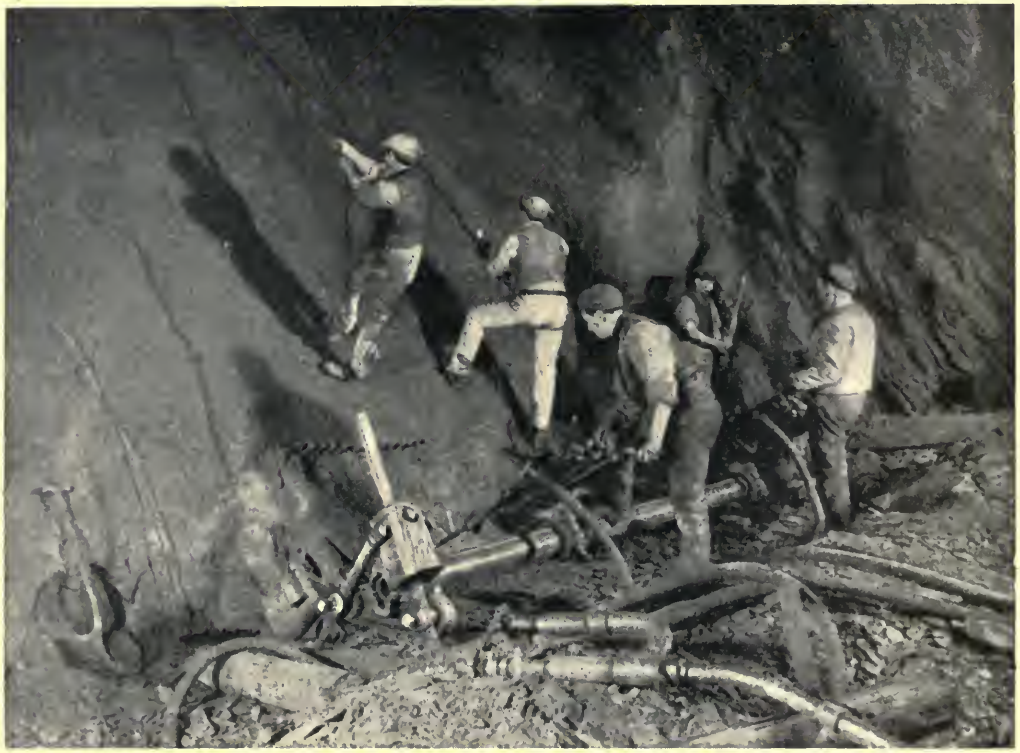


THE LAST HOUR OF A ROCK IN CORNWALL, MILLIONS OF YEARS OLD

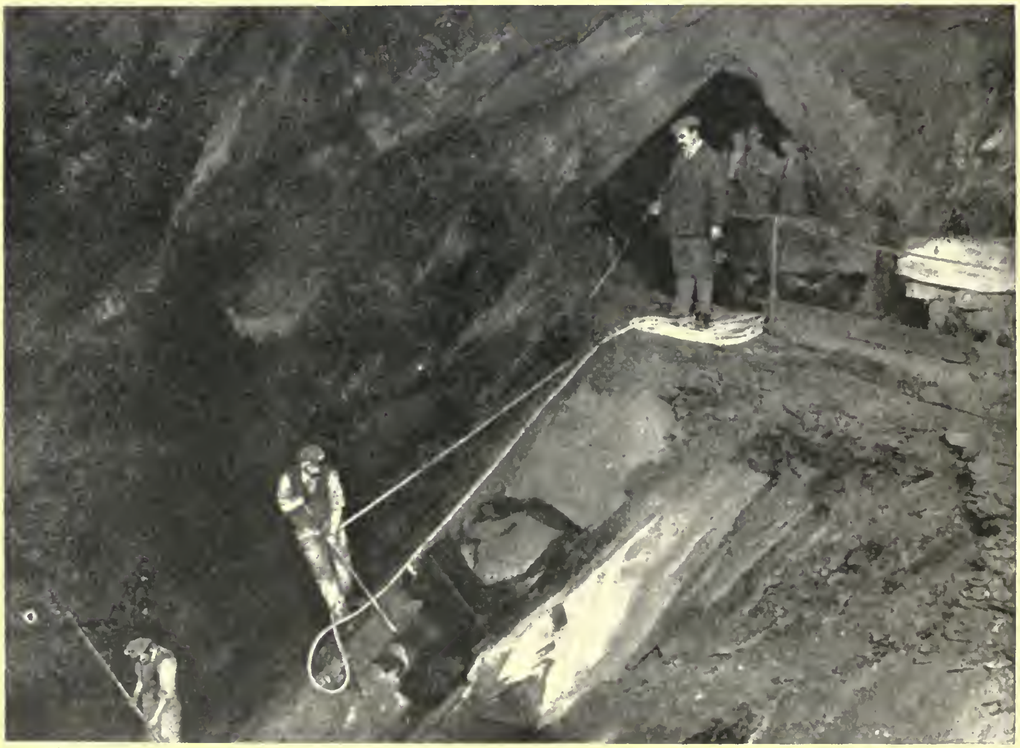


THE ROCK BEING BLOWN UP AND ABOUT TO FALL—THE MEN ARE HIDING IN LITTLE STONE HUTS, QUITE SAFE FROM DANGER

FORCING AN ENTRANCE INTO THE ROCK

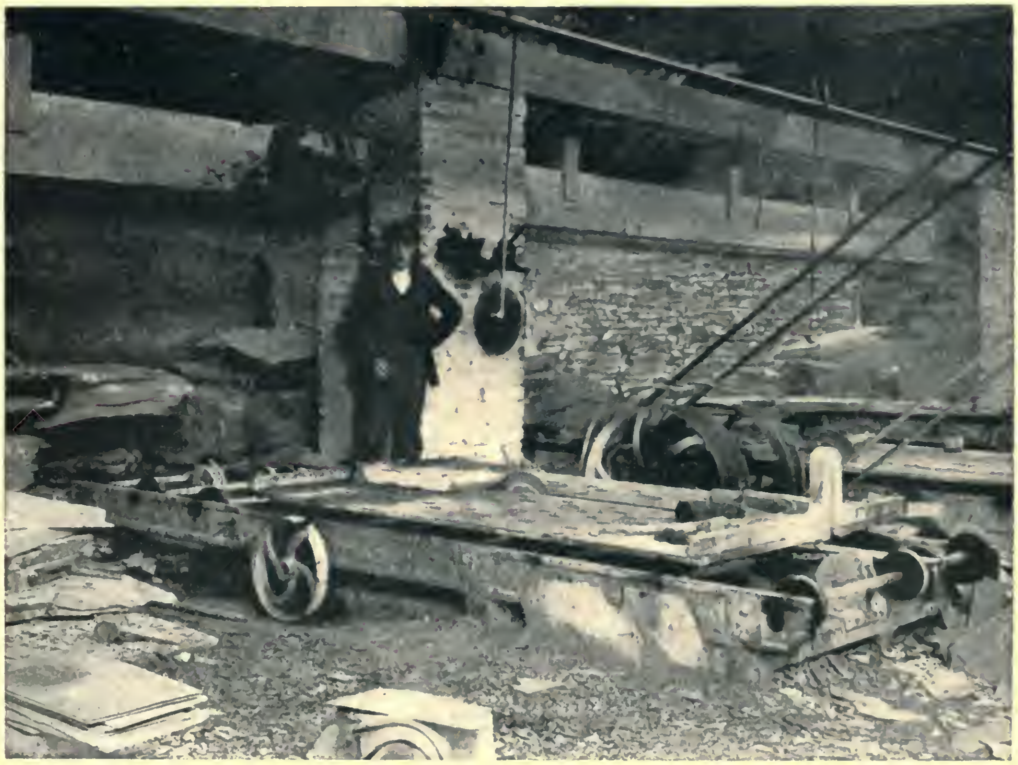


CUTTING INTO THE SLATE WITH A ROCK-CHANNELLER, CUTS BEING MADE AT RIGHT ANGLES TO EACH OTHER, SO THAT THE SLATE CAN BE REMOVED BY FORCING IN WEDGES

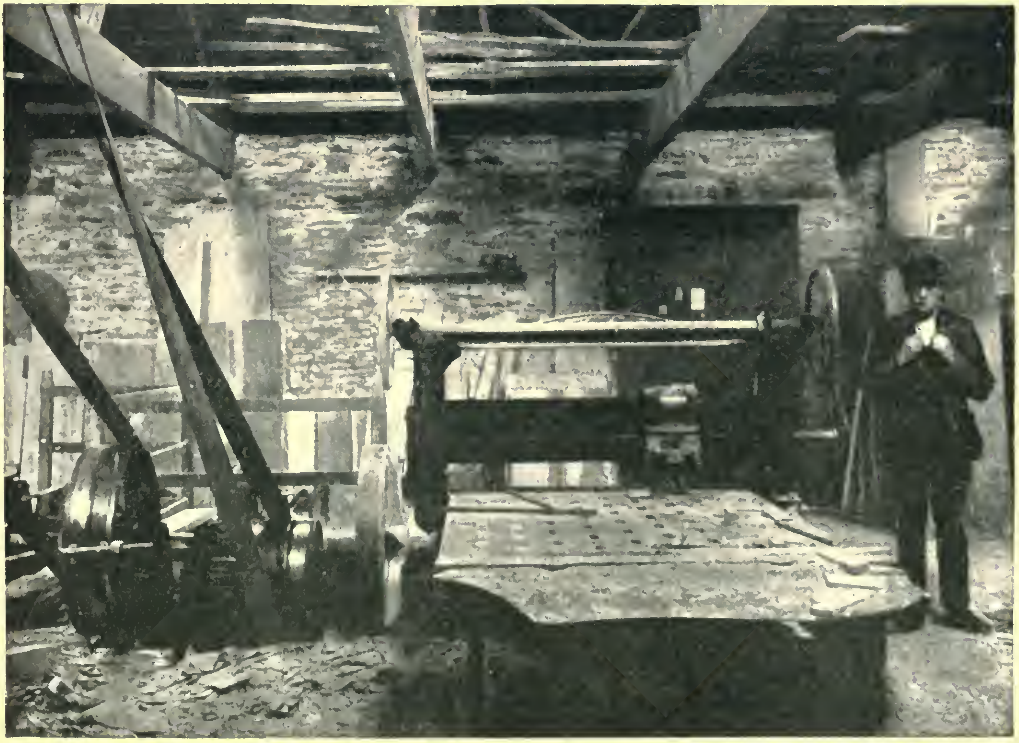


WHERE THE SLATE IS BELOW THE SURFACE IT IS QUARRIED IN UNDERGROUND CHAMBERS, AS SHOWN IN BOTH PHOTOGRAPHS ON THIS PAGE

ROOFS AND FLOORS FROM BROKEN MOUNTAINS

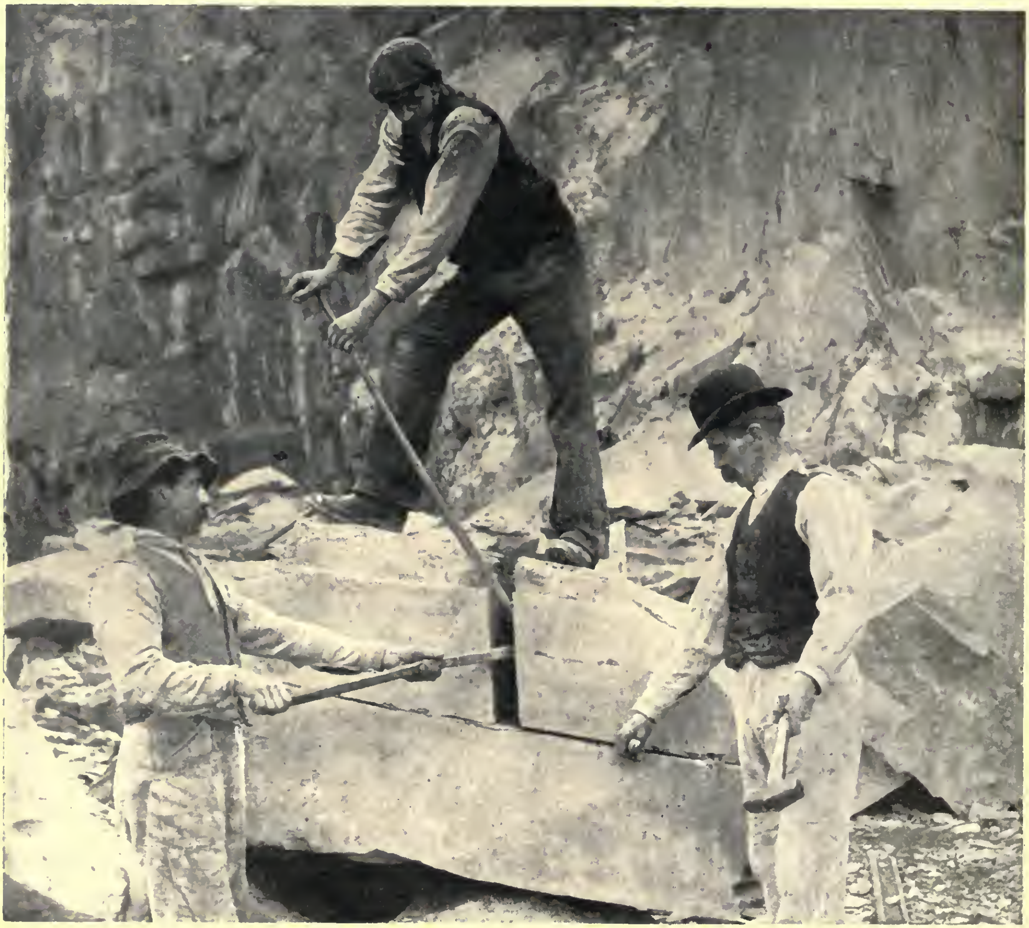


THE TABLE ON WHICH THE SLATE IS CUT TO THE PROPER SHAPE AND SIZE FOR ROOFING HOUSES

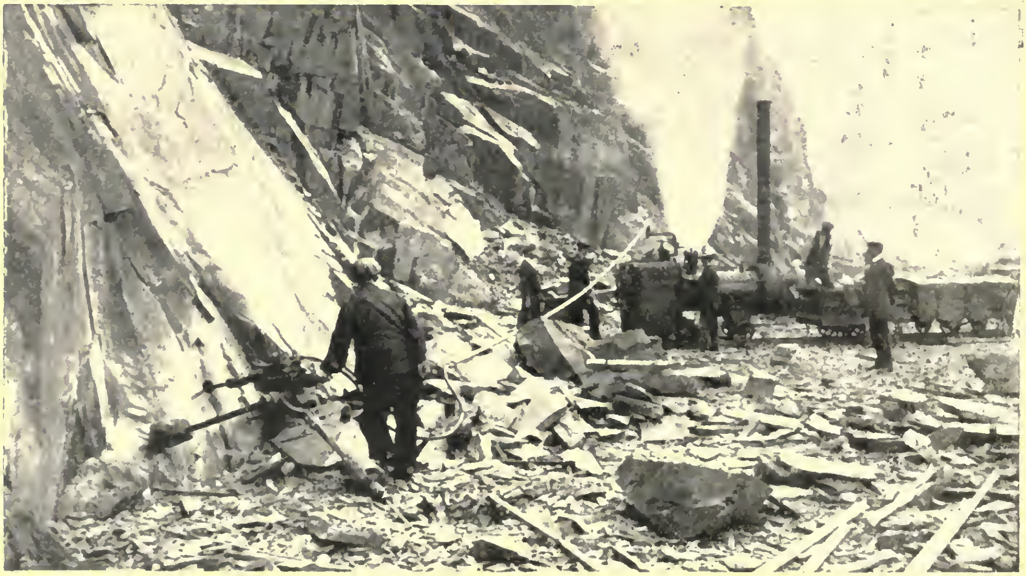


THE PLANING TABLE ON WHICH FLOORING SLATES ARE MADE LEVEL

BLOWING UP A MOUNTAIN WITH GUNPOWDER



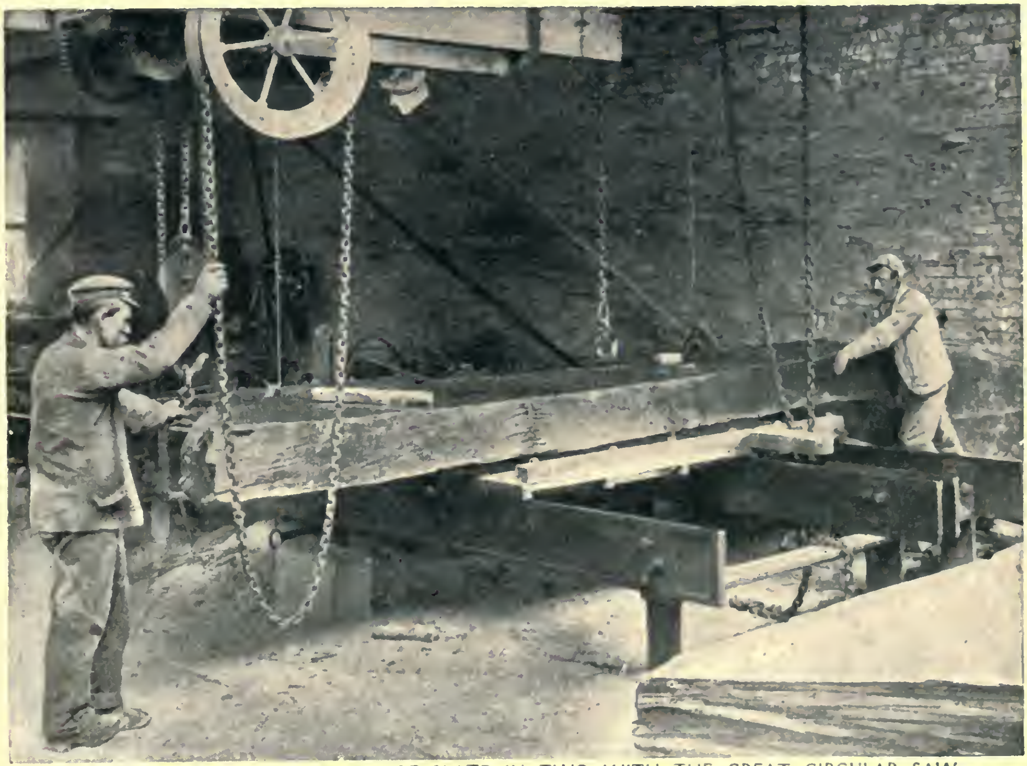
CUTTING UP A GREAT BLOCK OF ROCK INTO SMALL PIECES FOR MAKING SLATES



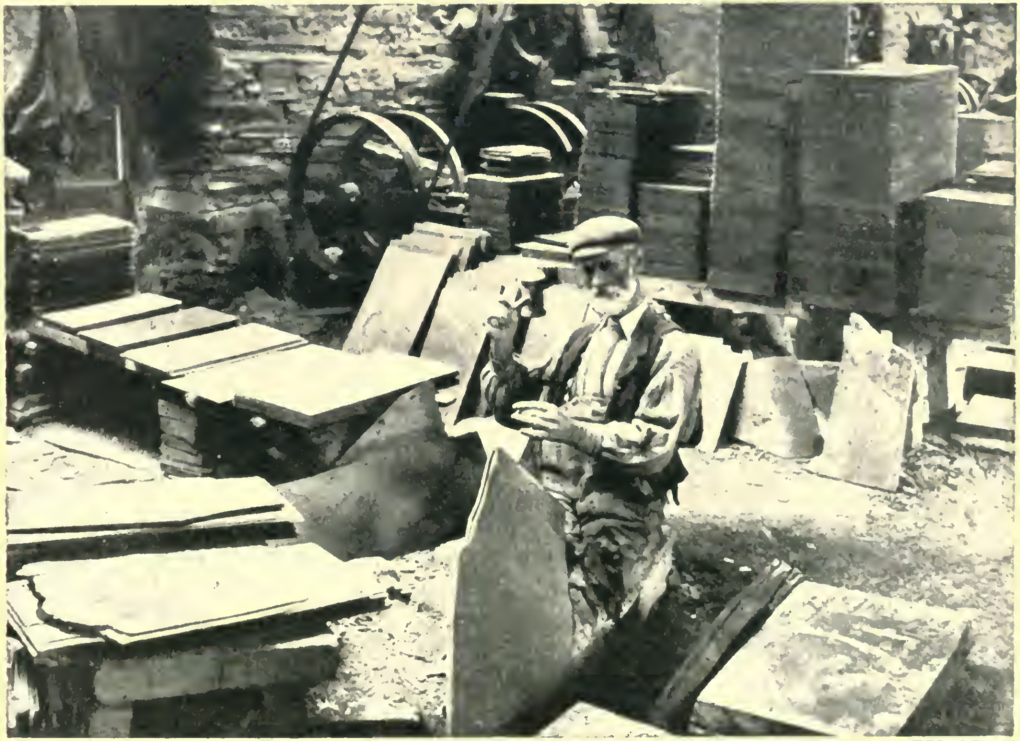
DRILLING A HOLE BY COMPRESSED AIR, READY FOR BLASTING WITH GUNPOWDER

These two photographs, and many others in these pages, were taken at the Dinorwic and Oakeley quarries, in North Wales.

SPLITTING AND CUTTING THE BLOCKS OF SLATE



CUTTING AN IMMENSE BLOCK OF SLATE IN TWO WITH THE GREAT CIRCULAR SAW



SPLITTING THE SLATE FOR ROOFING. THE FINISHED SLATES ARE USUALLY ABOUT A QUARTER OF AN INCH THICK, BUT VARY ACCORDING TO THE SIZE AND STRENGTH REQUIRED

THE AQUITANIA, ONE OF THE FINEST SHIPS YET BUILT

The latest wonder of the Atlantic is 901 feet long and 97 feet wide. If it were set on end beside the Woolworth Building, which is 51 stories high, it would reach 150 feet above it. Its gross tonnage is 47,000 tons and its speed is 23 knots. Though not as fast as the Mauretania, it is a much larger vessel and can carry more passengers and freight. It has eight passenger decks, affording accommodation for 3,250 passengers. It also accommodates a crew of 1,000 men. On its deck, ready for immediate use, are four large motor life-boats, each equipped with wireless apparatus. In case of accident, these would tow the many row-boats and collapsible rafts, carried for the rescue of passengers.

INSIDE AN OCEAN LINER

A PICTURE GALLERY OF A GREAT SHIP, THE FLOATING PALACE THAT LINKS ALL NATIONS

THE LITTLE WORLD THAT GOES TO SEA

A HUNDRED and fifty years ago Dr. Johnson declared that "a ship is worse than a gaol; there is, in a gaol, better air, better company, better conveniency of every kind." Probably he was right. But if Dr. Johnson could come back now and take a trip across the Atlantic Ocean, what would he say of the very latest type of liner, with its luxury and magnificence, its comfort undreamed of even a decade ago?

Nowhere in our social or industrial life has progress been so marked as in the improvement of ocean travel. The modern liner is often called a floating palace, and in some ways the description is not amiss, but it really falls far short of the truth. When we consider the vessel's gigantic size—the Olympic is nearly nine hundred feet long and a hundred feet wide—and the enormous number of passengers and crew that it carries—the Olympic takes between three and four thousand people with it—we feel that it is really a floating town, and that John Ruskin most admirably described the modern liner as racing to its port of destination as "a fragment of a world hastening to rejoin the great mass of existence." Well might he exclaim: "What a glorious monument of human invention has thus triumphed over wind and wave; has brought the ends of the world into communion!"

It has been said that the ships which now cross the Atlantic could have carried Columbus's caravel as one of their lifeboats. Two of the great explorer's ships that sailed on that momentous voyage to America had no decks at all, but the modern liner has a dozen decks one above the other, and, while from Columbus's ship a man could jump into the sea to rescue a companion who had fallen overboard, the depth from the top of the funnel to the keel of the Olympic is 175 feet, and from the captain's house to the keel more than 105 feet.

The engineering triumphs of modern shipbuilding are wonderful enough and seem like veritable miracles, but the comforts and luxury of travel are equally wonderful, and may well be described as fairy dreams or visions of the "Arabian Nights." For magnificence and convenience only the very best and biggest hotels on land can compare with a great ocean liner.

When the designers and engineers have done their work, and the ship is ready for decorating and furnishing, skilled architects are called in, as they would be for the arrangements of a royal palace, and the architects decide on the scheme of ornament for the various parts of the ship, the style of furniture, and so on.

Take any of the new liners, such as the Mauretania or the Vaterland. In the Mauretania there are rooms in the styles of the fifteenth, sixteenth, seventeenth, and eighteenth centuries; there are saloons copied from rich Italian and French palaces; there are Adams rooms and Chippendale rooms and Sheraton rooms. The impressive dome which rises above the dining-saloon to a height of nearly thirty feet is in the style of the beautiful Château of Blois, one of the architectural glories of France. In the lounge are massive pillars of marble, with a huge chimney-piece of the same choice material, while the very grates—for the modern steamship is fitted with open grates—are reproductions of originals in mediæval Italian palaces. The fireplace in the smoking-room of the Mauretania is surmounted by a superbly carved wooden hood, copied from a work of one of the famous artist brothers of Florence, the Della Robbias, in the South Kensington Museum.

In all these rooms the old-fashioned port-holes have given place to large, semicircular bay windows such as we find in a palace. It is, indeed, really difficult, on board one of these liners, to realise that we are not in a luxurious hotel on land. The Olympic has more than two thousand windows and side-lights. There are on these great ships greenhouses and palm-courts and verandah cafés; there are gymnasiums and swimming baths, and Turkish baths and tennis courts, and the very latest ships have even a small golf course. So far from being confined as in a prison, the first-class passengers have a promenade deck nearly twenty thousand square feet in extent. Large swing doors give access to the various saloons and lounges, and although there are spacious staircases that would do credit to the palace of an emperor, the passengers are not obliged to use them, but may go from deck to deck by means of smooth-running electric lifts. On the Mauretania these are protected by an artistic grill of finely wrought aluminium copied from a rare piece of wrought iron-work of the fifteenth century. In seeking for choice woods with which to panel the various saloons, England and France were both ransacked. The furniture is equally magnificent, and in some of the rooms on our largest liners valuable ancient tapestries hang on the walls.

A CORNER OF A DINING-ROOM ON AN OCEAN LINER

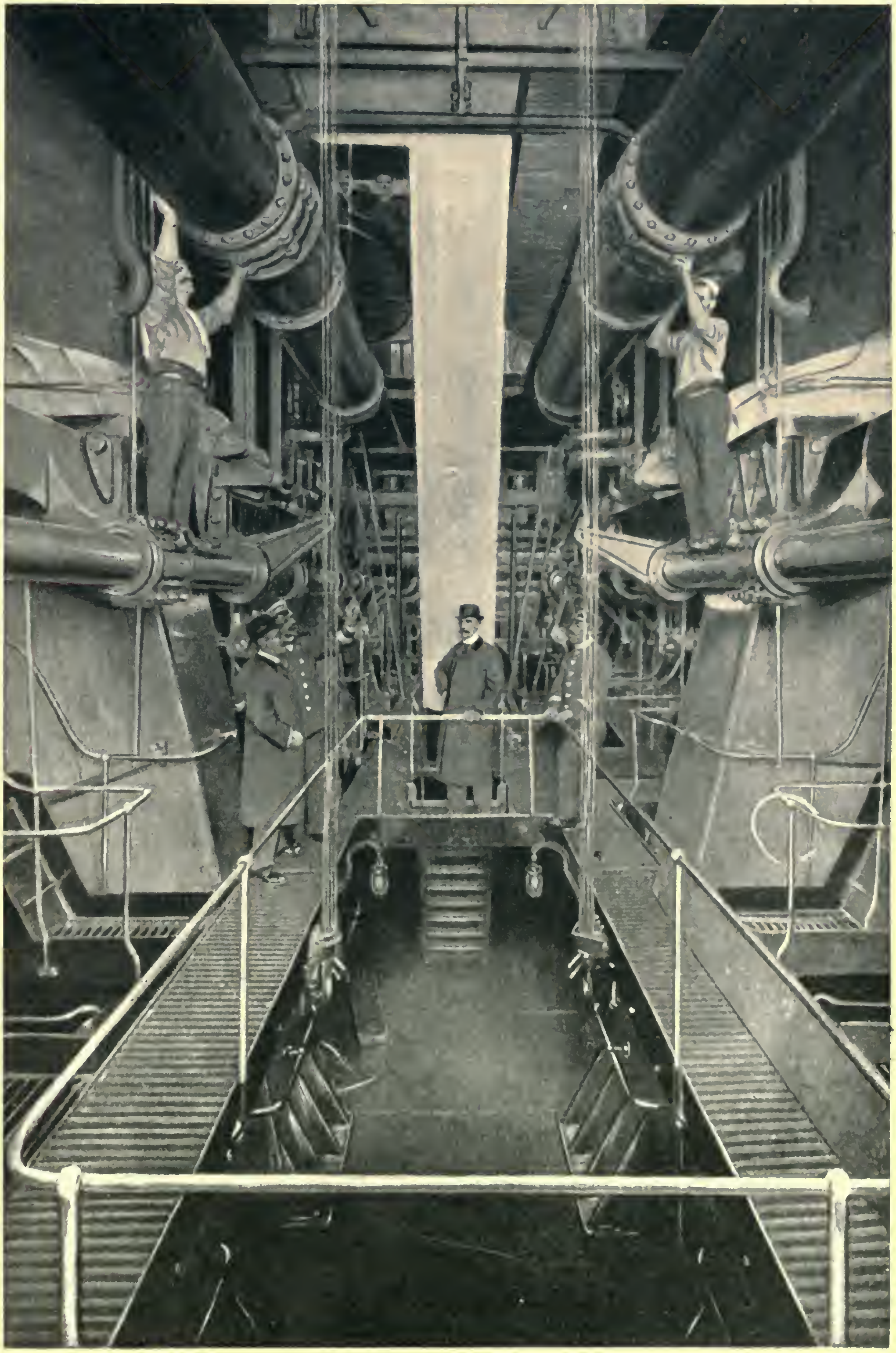
The artificial lighting of these ocean palaces seems almost like a dream. On the Mauretania, in the great saloons, hidden electric lamps throw light against a gilded disc, and a soft glow is diffused over the rooms that has almost the appearance of warm sunlight. There are six thousand electric lamps and a thousand bells, and to transmit the electricity to these lamps from the dynamos 250 miles of copper wire is used.

Little travellers are not forgotten, a special saloon being provided for them, with rocking-horses and games of all kinds; while the walls are decorated with paintings illustrating nursery rhymes and stories. For older people, the gymnasium contains not only the usual fittings and appliances, but mechanically worked horses and oars, so that passengers can enjoy the exhilarating exercises of a ride or a row before breakfast.

The private suites of apartments are just as luxurious as the great saloons. They are fitted, not with bunks, but with beautifully carved brass bedsteads, full-size wardrobes and dressing-tables, and bathrooms.

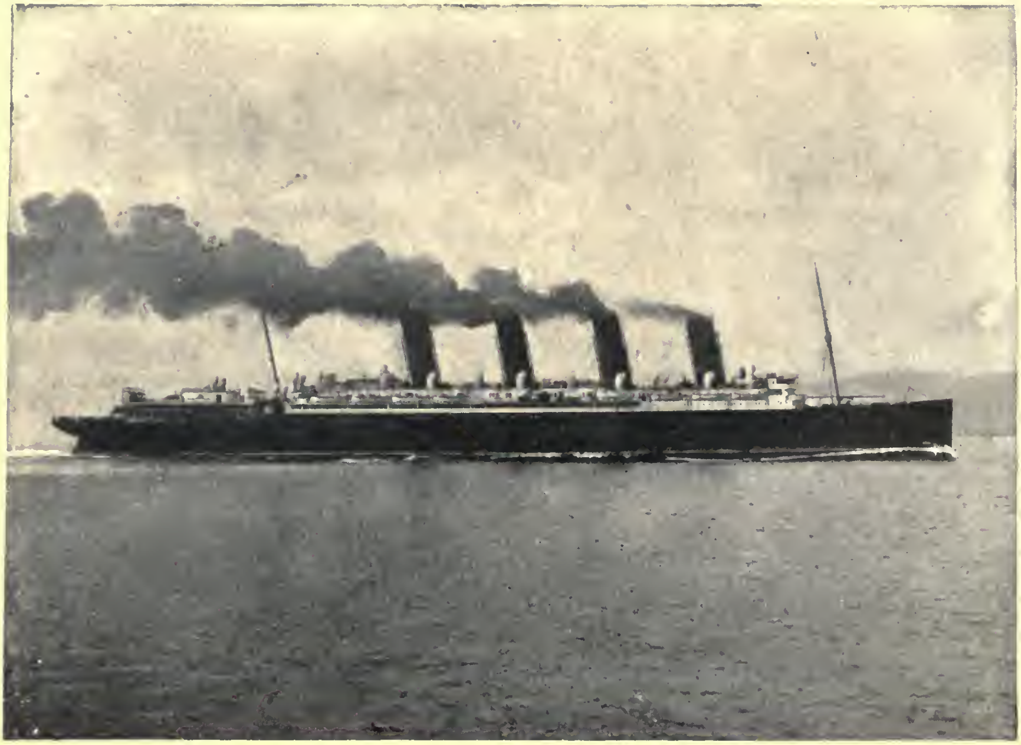
The ventilation of these great steamships has been brought to a fine art. A few years ago fresh air was conveyed below by means of ventilating shafts, down the funnel-like heads of which the air was blown as the vessel ploughed forward. Nowadays such crude methods are almost forgotten on the best ships. There are special ventilating machines, called thermo tanks, connected with the various rooms, which change the air in these apartments a dozen times an hour. While the foul air is drawn out, the fresh air is pumped in gently, and warmed. The total length of piping through which this fresh air is carried on the Mauretania is over three miles. The best cabins are fitted with the telephone, and when the vessel comes into port she is at once connected with the whole telephone system of the country. The food arrangements are carried out exactly as if the ship were an hotel on land. Cows give fresh milk daily, and refrigerators keep poultry, meat, fish, and other foods perfectly fresh. It is odd to think back to the days of ship's biscuits, salted pork, and stale water, the travelling luxuries of a hundred years ago. After travelling across the Atlantic now, we feel, with Ruskin, "thankful to have lived in an age when we can see this thing so done."

DOWN AMONG THE ROARING ENGINES

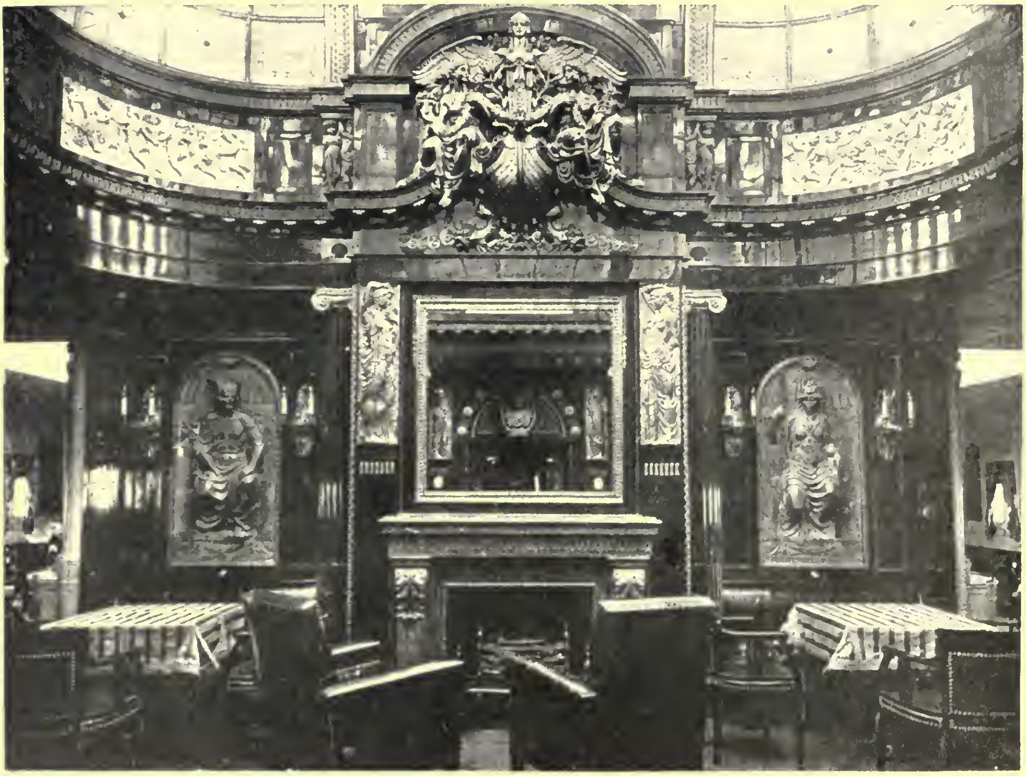


IN THE ENGINE-ROOM OF A GERMAN STEAMSHIP

THE SHIP THAT LINKS THE NATIONS



THE MAURETANIA, ONE OF THE GREATEST LINERS CROSSING THE ATLANTIC OCEAN



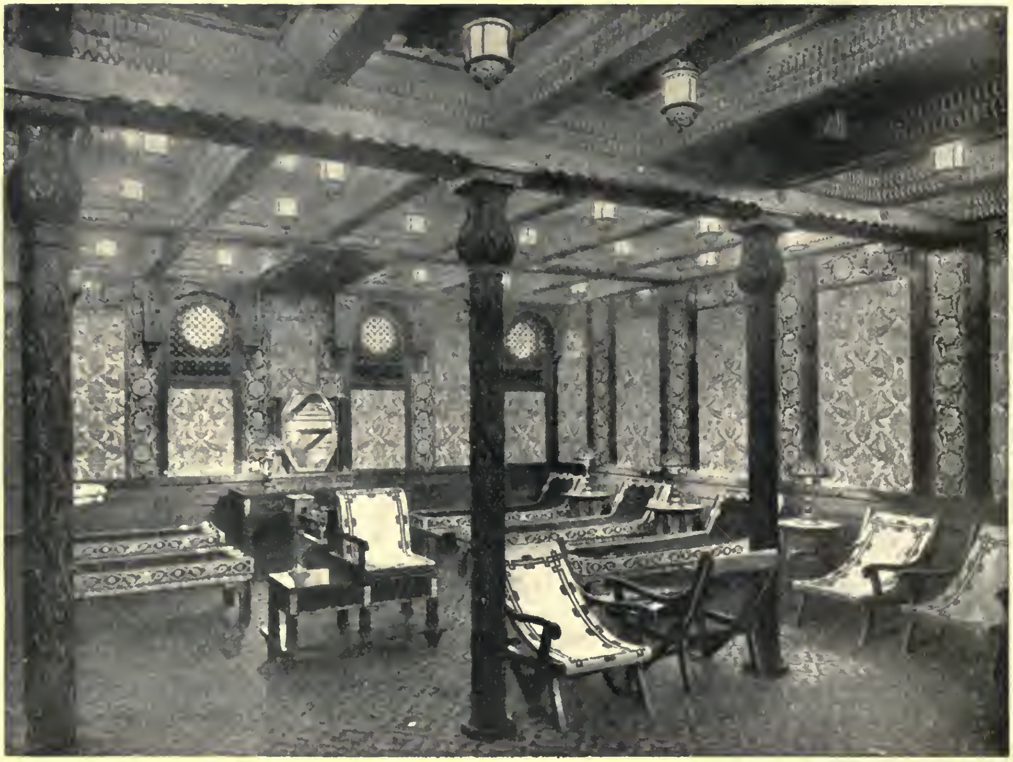
THE HANDSOME DECORATION OF A SMOKING-ROOM ON AN OCEAN LINER

THE SISTER SHIP OF THE DOOMED TITANIC

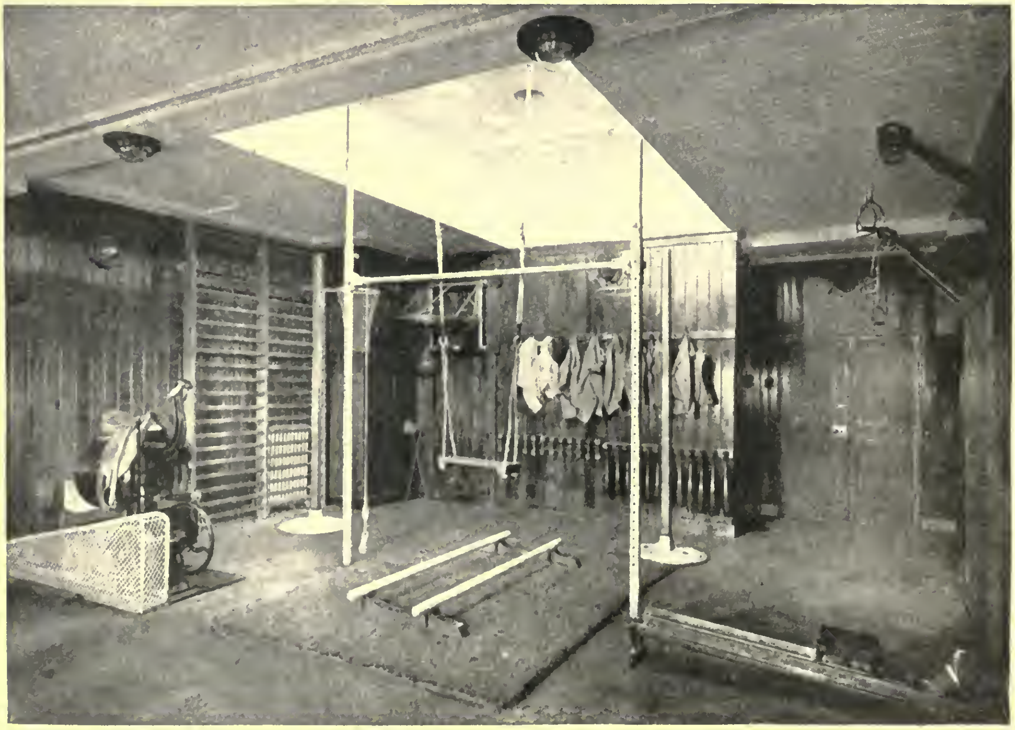
THE SPLENDID FITTINGS OF THE INTERIOR OF THE OLYMPIC

THE PICTURES ON THE INNER "WALLS" OF THE OLYMPIC. SISTER SHIP OF THE TITANIC

HEALTH AND EXERCISE AT SEA



A TURKISH BATH ROOM ON THE OLYMPIC



A GYMNASIUM ON BOARD A GREAT ATLANTIC LINER

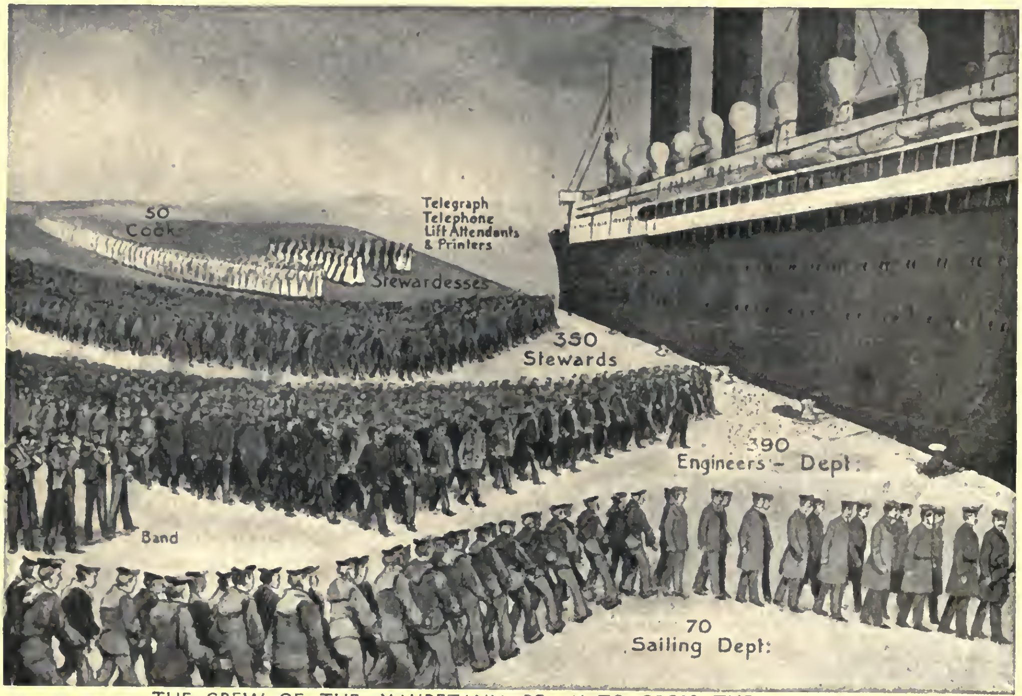
THE GREAT SPACES ON A GREAT SHIP

THE MAIN STAIRCASE LEADING FROM THE SALOON OF A WHITE STAR LINER

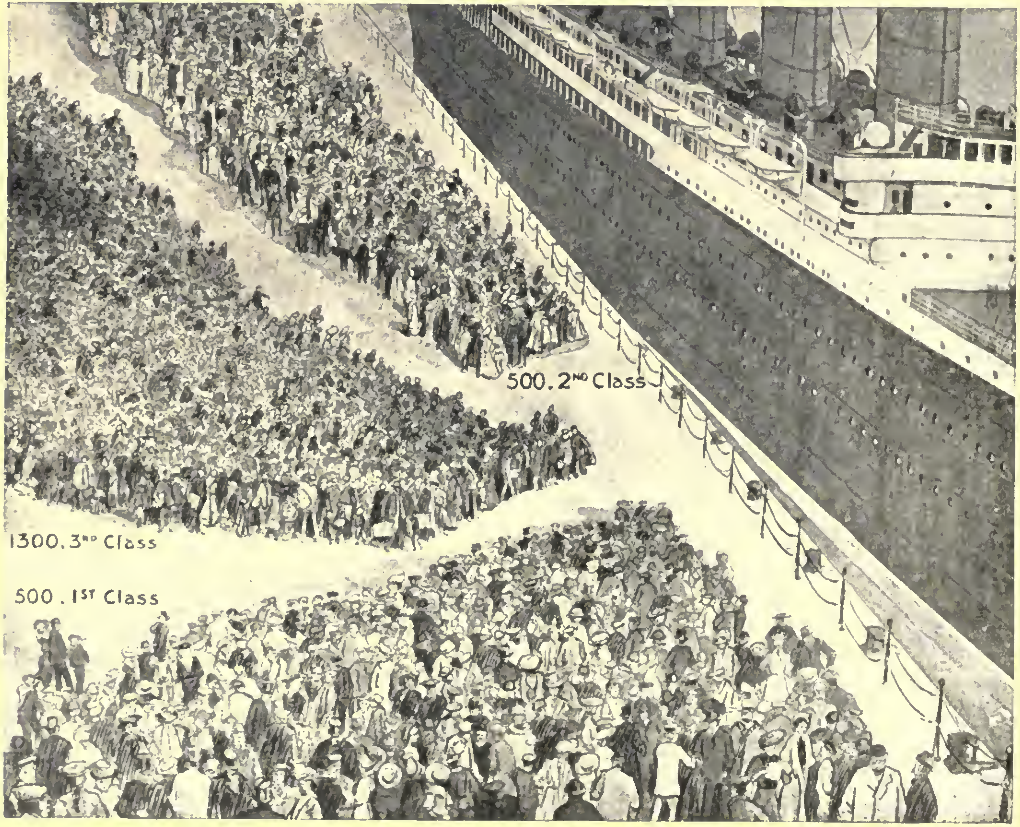
THE GREAT DINING-ROOM ON AN ATLANTIC LINER

A RECEPTION-ROOM REACHING ACROSS THE WHOLE WIDTH OF THE SHIP

THE GREAT HOST THAT CROSSES THE ATLANTIC

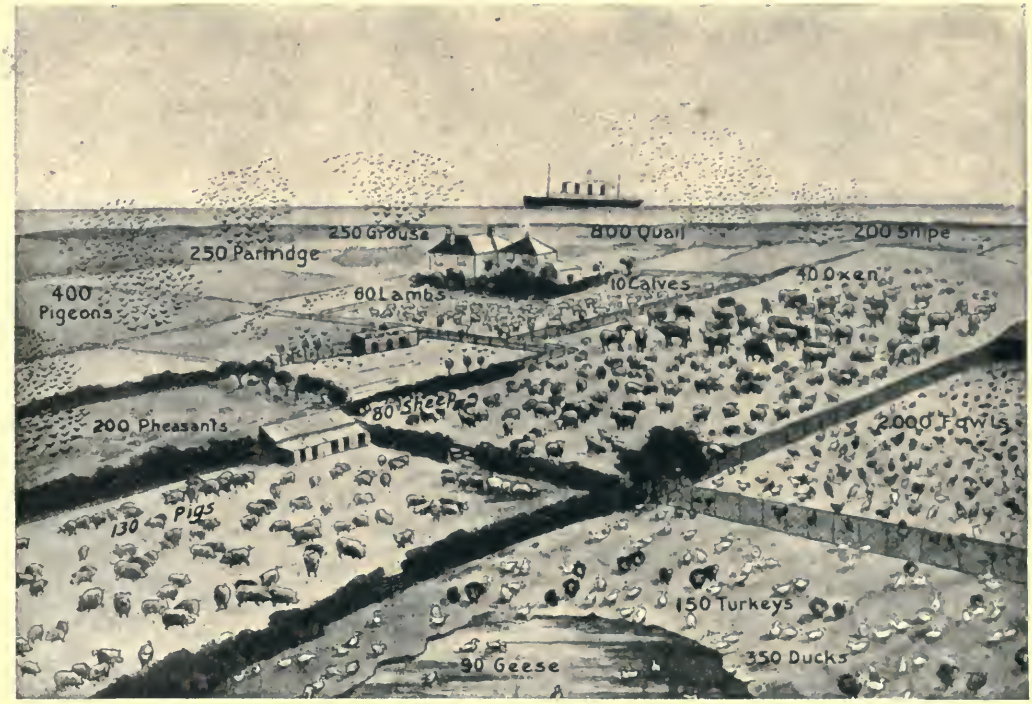


THE CREW OF THE MAURETANIA READY TO CROSS THE ATLANTIC

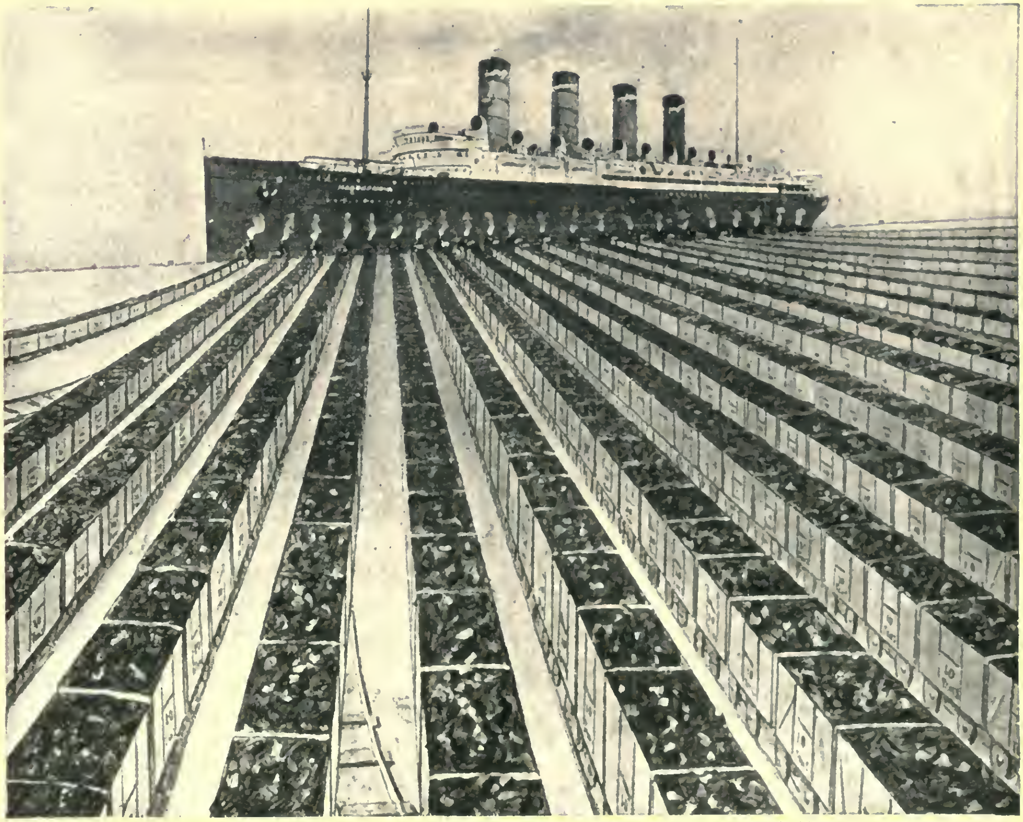


THE PASSENGERS OF THE MAURETANIA ARRIVE AT THE SHIP

THINGS THAT DISAPPEAR ON THE JOURNEY

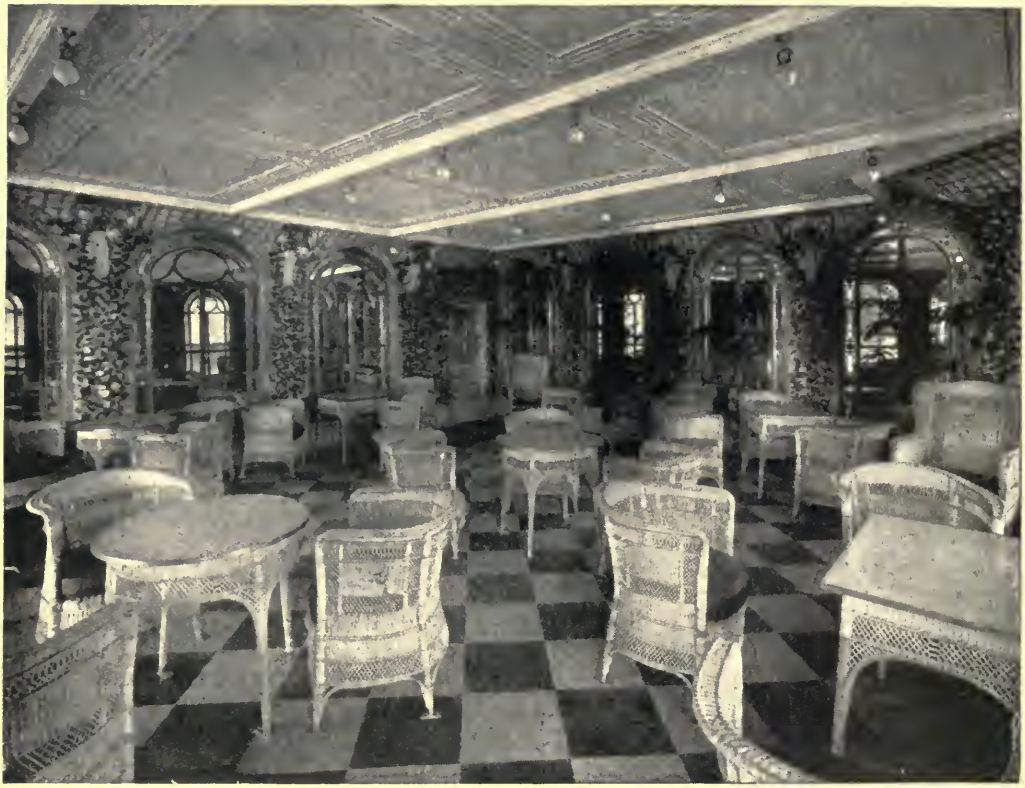


THE FARM SUPPLIES OF A GREAT SHIP, INCLUDING NEARLY 5,000 ANIMALS AND BIRDS

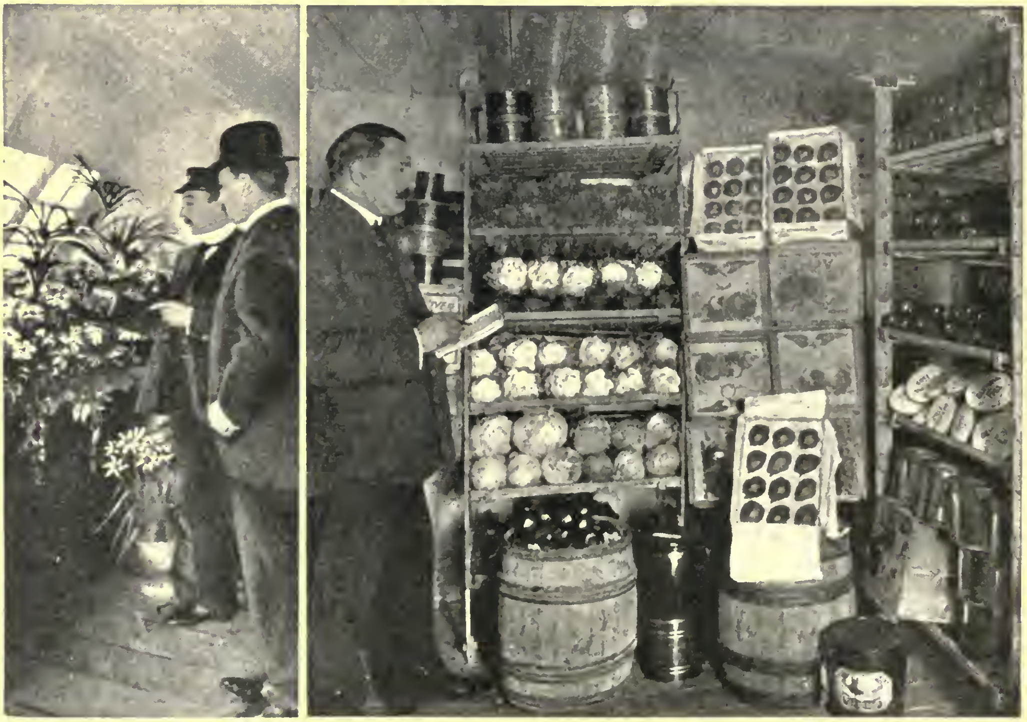


THE COAL THAT TAKES A GREAT SHIP ACROSS THE ATLANTIC—22 TRAINS CARRYING 300 TONS EACH

A TOUCH OF THE COUNTRY AT SEA

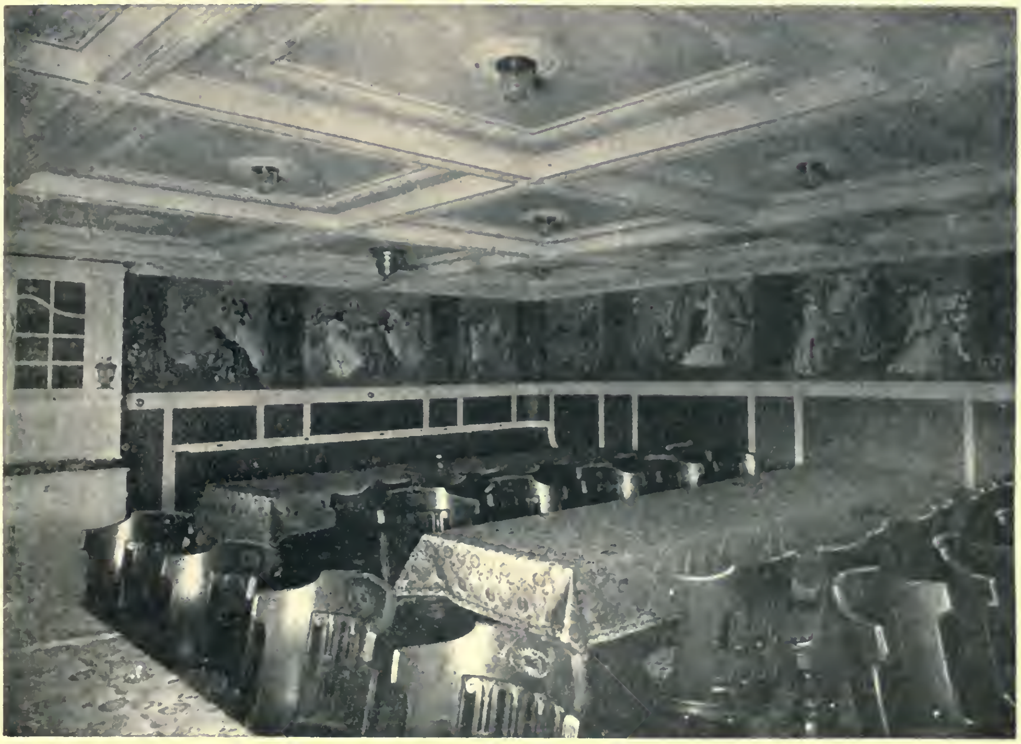


A CHARMING TEA-ROOM ON AN ATLANTIC STEAMSHIP, WITH REAL CREEPERS GROWING

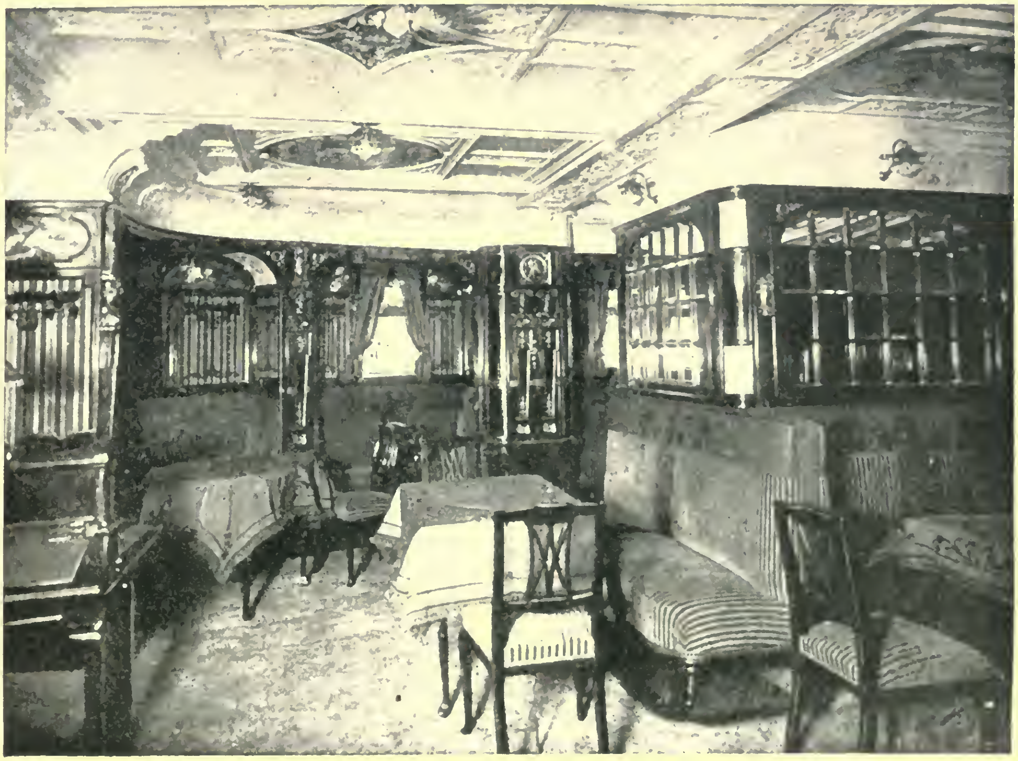


GROWING FLOWERS AND STORING VEGETABLES FOR THE TABLES

COSY CORNERS ON THE RAGING BILLOWS



A COSY CHILDREN'S DINING-ROOM ON A GERMAN STEAMSHIP



THE SNUG READING AND WRITING ROOM ON A GERMAN STEAMSHIP

A FEARFUL RISE SIX MILES ABOVE THE CLOUDS

AT A HEIGHT OF SIX MILES ABOVE THE EARTH WITH HIS COMPANIONS HELPLESS, A BALLOONIST, FEELING THE SLEEP OF DEATH CREEP OVER HIM, AND LOSING THE USE OF HIS LIMBS, SEIZED A CORD WITH HIS TEETH, OPENED A VALVE, AND LET OUT THE GAS SO THAT THE BALLOON FELL SOME MILES TO SAFETY

THE SEA ABOVE OUR HEADS

JOURNEYS IN THE GREATEST OCEAN ON THE EARTH, AT THE BOTTOM OF WHICH YOU LIVE

THE THRILLING LIFE OF EXPLORERS OF THE AIR

MEN think that the life fishes lead in the depths of the sea is very strange and wonderful. So it is. But still more strange and wonderful is the life we lead ourselves at the bottom of the greatest ocean on the earth. We pass our existence moving on the bed of a blue sea of air, hundreds of miles deep, and greater in area than all the land and water of our world. An ordinary man would find it very hard to carry always about with him something weighing a hundredweight, yet he is not troubled by the tremendous weight of sixteen tons with which the air presses on the surface of his body. Whether he sits or walks or lies down, the vast ocean of air above him is pressing hard upon his body with the weight of sixteen tons, but, far from being aware of this extraordinary weight, he enjoys it, and actually suffers great pain if he escapes from his mighty burden.

It is not difficult to lighten the weight of the air that presses upon us. We have only to climb up some very high mountain, such as one of the lower Andes, in South America, which rises to a height of three miles above the sea. On such a mountain-top the air is very light, and the weight with which it presses on the body is not very great. But, instead of feeling a joyful lightness, a mountain climber often suffers terribly when the pressure of the air is reduced. In some cases blood will begin to flow and he will find it hard to walk or move. And if, with a great effort, he climbs still higher, he will at last fall senseless on the ground. Horses and mules suffer in the same way if they are taken very high up a mountain; even the little mountain camel of the Andes, the llama, can scarcely walk when it gets 15,000 feet above the sea.

All this is due to the fact that our bodies are constructed to bear the enormous weight of the ocean under which we live. Moreover, the force of the air acts equally all round us, and enters our bodies and thus helps to balance the outward pressure. We are really like some fishes that live at a great depth below the waves, and have grown so used to the weight of the water that they are injured if an accident brings them near the surface of the sea, where the weight of the water is only very slight.

Just as these fishes keep deep down below the surface of the water, so men keep deep down below the surface of the air, and this is why there are still high mountains in the world, such as Mount Everest, in India, which no man has been able to climb. At a height of six miles above sea-level, the weight of the air is so light that our bodies cannot stand it. Of course, the air at this distance above the earth is also thin as well as light, and there is not enough of it to breathe. This difficulty, however, can be overcome by carrying a supply of oxygen, such as brave men take with them when they descend a mine after an explosion.

But even when the lungs are thus supplied with oxygen the chief difficulty in ascending to the top of a mountain is not yet overcome, for the body of the daring climber still cannot stand the removal of the greater part of the sixteen tons of air-pressure to which it is accustomed. The blood-vessels give way, and if the climber does not descend quickly he dies. This is why the work of climbing up the ocean of air is so terribly difficult. It is only in the last hundred years or so that men have even attempted to explore the sea above our heads. And even now the flying men can scarcely help us in this perilous work of exploration. The most powerful bird cannot reach the top of the highest mountain, and neither can the most powerful flying machine. The air is too thin. Yet it is said that the condor of the Andes can withstand a reduction in the pressure of air which would make blood flow from the lips and fingers of a man, and some mountaineering races have been known to live for centuries at a height of nearly three miles above the plain, growing so used to the light weight of the air that they suffer in descending to the lowlands, where the air is much denser and heavier.

Still, neither the flying man nor the mountain climber has been of much help in enabling man to sound the deep ocean of air ; but, at least, man has discovered with their aid what it is like above the clouds. It has been calculated that the highest kind of cloud usually forms at a height of thirty thousand feet. It consists of light, feathery wisps of vapour that have been turned into crystals of snow by very cold, strong winds that carry them along at a speed of eighty to a hundred miles an hour. Far below these sailing snowflakes are the ordinary clouds of white vapour, which sometimes turn the sky into a strange and lovely region of cloud castles and fairy palaces, set among wildly shaped masses of changing vapour.

A PICNIC IN THE GLORIOUS SUN ABOVE THE CLOUDS

This lovely cloudland usually lies at a distance of little more than a mile from the earth, and it is quite easy to get above it by climbing to a high mountain-top. It was while gazing at it from the banks of a river in Southern France that two brothers, Joseph and Jacques Montgolfier, dreamt of ascending into the sky by means of a cloud! The thought occurred to them one summer day in 1782, as they lazily talked together at Avignon, and looked at the great mountains of cloud slowly moving above the broad waters of the River Rhone. Their father was a paper manufacturer at Annonay, a small town some miles from Lyons, and the two brothers appear to have begun by making experiments with paper bags filled with smoke.

They thought if they could enclose vapour like that of which clouds are made, in a large and very light bag, the vapour would rise in the air and carry the bag with it. This vapour they secured by burning damp straw and wool. As a matter of fact, they obtained from their fires merely ordinary smoke and a good deal of hot air ; and, by getting this into a paper bag, they made a primitive kind of balloon which rose for a great distance in the sky, and then fell as the hot air escaped from the paper covering. They were so excited by the success of their artificial cloud that, on returning to Annonay, they made a much larger and stronger linen bag, lined with paper and tapering at the bottom. By burning chopped straw and wool beneath this, they quickly filled the huge ball with hot air and smoke. When the balloon was swollen out with hot air, it was set free in a field near Annonay, where an immense crowd of people had assembled. Amid

PHOTOGRAPHING HER SHADOW ON THE CLOUDS

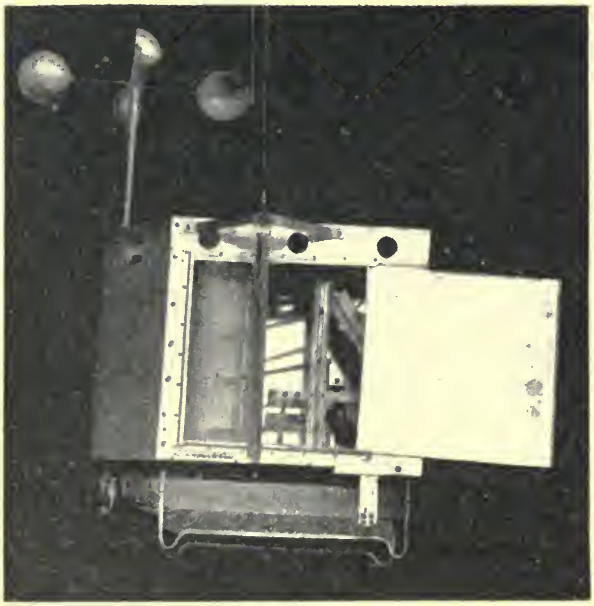
TAKING A PHOTOGRAPH FROM A BALLOON OF THE SHADOW OF THE BALLOON ON THE CLOUDS

THE BALLOON RETURNS TO THE BOTTOM OF THE OCEAN OF AIR AFTER A VOYAGE TOWARDS THE SURFACE their shouts of amazement and delight, the great ball rapidly ascended to a height of 6000 feet, and travelled at this altitude for about a mile and a half. Then the vessel descended to the earth, so lightly as not to damage the grain and vines among which it fell.

The news of this wonderful ascent spread rapidly through France, and the people of Paris raised a large sum of money by public subscription, and asked one of their famous men of science, Professor Charles, to design a balloon for them. Professor Charles knew more of the properties of the air than the Montgolfier brothers. He saw that the success of their experiment was due to the fact that, in attempting to make an artificial cloud, the brothers had merely filled their linen bag with hot air; and, as the hot air was much lighter than ordinary air, it had caused the great bag to rise.

Now, an English man of science had discovered a new gas which was seven times lighter than air, and Professor Charles saw that, if he could fill a large balloon with this new gas, it would rise a great deal higher than a bagful of hot air. The new gas was called hydrogen, and it could be made by filling a cask with iron filings and water, and putting some sulphuric acid into it. The professor let the sulphuric acid slowly enter through a pipe in the top of the cask, and by means of another pipe he drew off the gas that formed and conveyed it into a balloon. It took four days to make enough gas, but at last, at six o'clock in the evening of August 27, 1783, the first real modern balloon was sent up from the Champ de Mars, in Paris, in the presence of a great crowd of two hundred thousand people.

Great cannon were fired as the balloon rose, but after a short voyage the balloon itself exploded in the skies. Professor Charles had ordered the men only to half fill the balloon with gas, but, thinking to make it go higher, they disobeyed him and filled it completely. The result was that the gas expanded when the balloon rose above the first level of the clouds and was warmed by the sun, and the balloon fell in a little village fifteen miles from Paris, and the villagers thought some dragon of the skies had descended upon them. Hastily arming themselves, they crept up to the split gas-bag, which was still partly filled with gas and quivering in the wind, so that it looked like some huge injured creature panting for breath. After waiting for some time, in the hope that it would rise up and fly away, one very brave man approached and fired a charge of shot at it. The shot tore open the uninjured part of the bag and allowed the rest of the gas to escape; and, seeing that the strange monster had collapsed, the villagers rushed upon it with pitchforks and tore it to bits.



THE WONDER-BOX CARRIED UP INTO THE CLOUDS AS SHOWN ON THE OPPOSITE PAGE

The three instruments attached to the box write their own impressions on the clockwork cylinder seen inside.

But the next day the King of France issued a proclamation, explaining that balloons must not be injured, because, being merely globes of silk filled with gas, they were not dangerous, but would prove of great value to mankind.

The first man to make use of the new invention was a young French man of science, Pilatre de Rozier, who was one of the king's librarians. With great difficulty he obtained leave from the king to make a balloon ascent, and on November 21, 1783, he sailed over Paris. He rose to a height of about 500 feet and descended about 9000 yards from the place of ascent. A few years later he made a double balloon, which was a large gas balloon with a fire balloon placed underneath. By increasing or diminishing the fire he could ascend or descend without waste of gas. In this double balloon he attempted to cross from France to England, but the balloon caught fire and the daring æronaut met a tragic death.

For some years the Frenchmen remained the most daring explorers of the air. In 1804, for instance, one young French chemist, Gay-Lussac, ascended to a height of 23,000 feet in a balloon provided with various scientific instruments. He had boxes for taking samples of air at different heights, and instruments for measuring the amount of electricity and magnetism in the atmosphere and recording its pressure and dryness, and so on.

He found that the air grew colder and colder at every three hundred feet of elevation, and for the greater part of a century his observations were supposed to be true for the entire height of our atmosphere. At every three hundred feet his thermometer showed that the air became one degree colder, and it was by making calculations on this basis that later men of science arrived at their ideas of the awful coldness of the empty spaces of the upper air. The strangest thing about Gay-Lussac's remarkable voyage of nearly four and a half miles above the earth was that he seems to have felt no pain or discomfort. No mountaineer had been able to attain such a height, and at a much lower level the climbers had suffered greatly from the thinness and lightness of the air.

This seemed to prove that the balloon was by far the best means of exploring the aerial ocean, but, strange to say, men of science soon tired of the wonderful invention which had been made especially for them. For half a century the balloon was used only as a form of public amusement, and it was largely due to Englishmen that the study of the upper air was at length seriously taken up. The British Association first entrusted Mr. John Welsh, of Kew Observatory, with the task of making voyages of exploration, and Mr. Welsh ascended to 23,000 feet, and made valuable additions to our knowledge of the wonderful sea of gases in which we live.

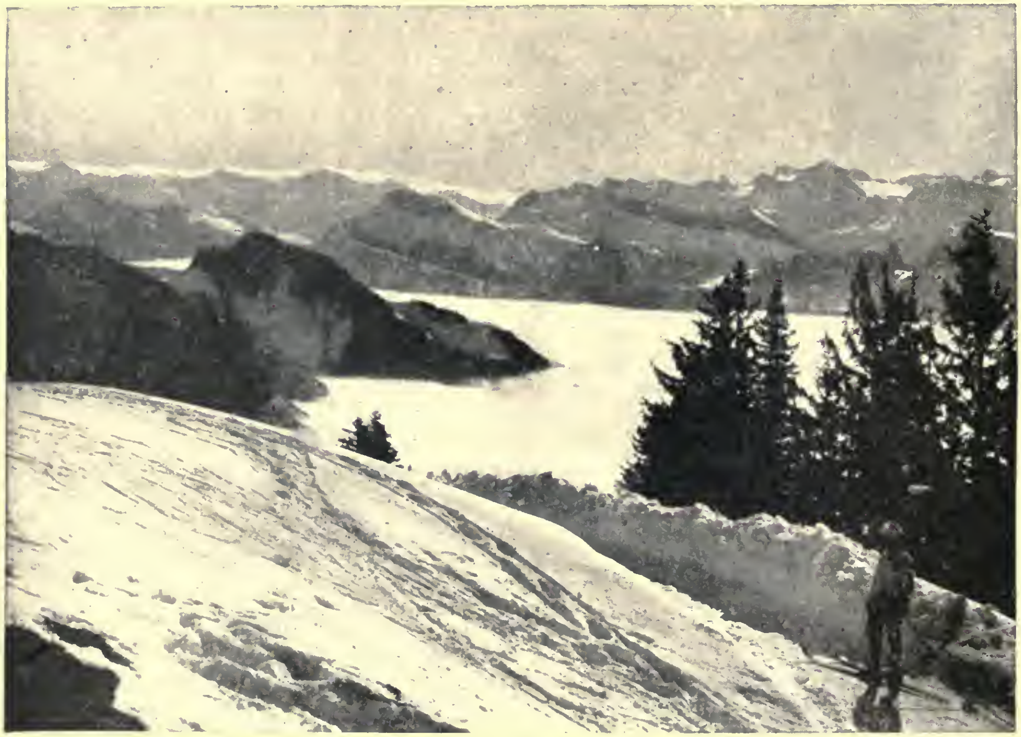
Then the most famous of all explorers of the aerial ocean, Mr. James Glaisher, took up the work. At Wolverhampton, on September 5, 1862, he rose in a balloon to the extraordinary height of seven miles. It took him less than one hour to surpass all other explorers by reaching a height of five miles. He felt there no discomfort, but his assistant, Mr. Coxwell, began to breathe with difficulty. Then suddenly the trouble came. Mr. Glaisher found that his eyesight was going. He could not even see the time by his watch. When the balloon was 20,000 feet above the earth the daring explorer leant his arm upon the table on the car, but when he tried to move his hand to reach an instrument he found that he could not move. He could still dimly see Mr. Coxwell, but had no power to speak to him. The balloon was still rising, and Mr. Glaisher suddenly found himself in absolute darkness. His eyesight had gone; and as he was trying to think what had happened to him he heard the words "temperature" and "observation," and understood that Mr. Coxwell was speaking to him. But he himself could neither see nor speak nor move.

After a time he recovered his senses, and found Mr. Coxwell standing over him. His brave assistant had had a terrible struggle for life. Feeling the sleep of death

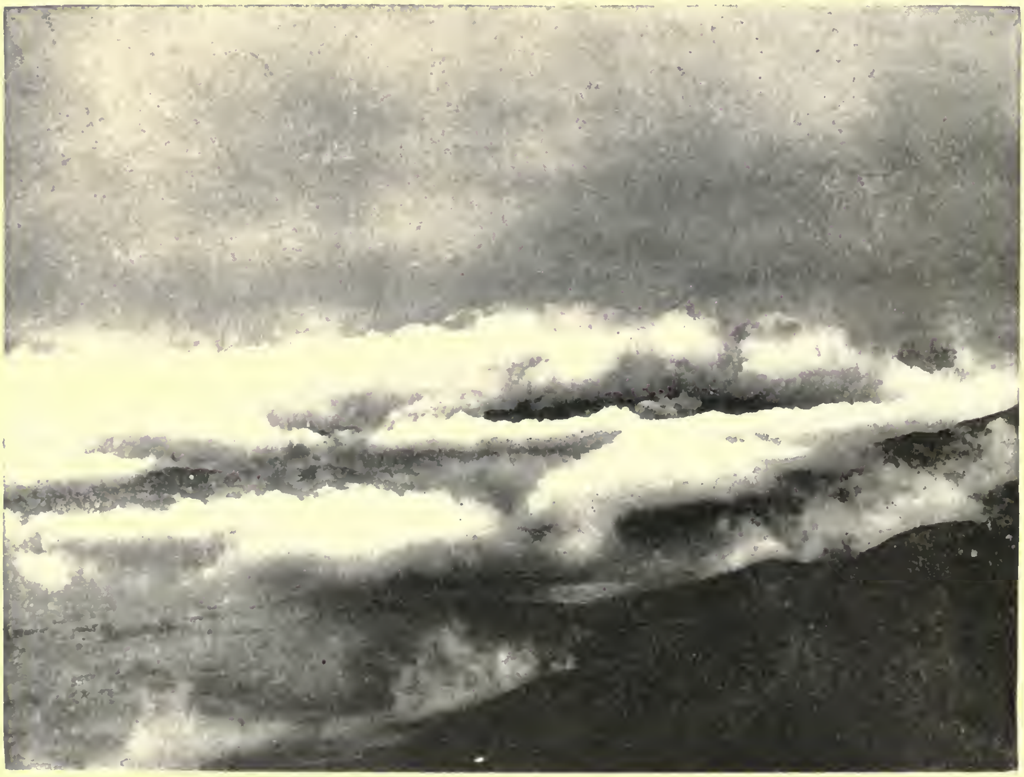
THE KITE THAT CARRIES UP THE WONDERFUL BOX

In the box at the end of the cord, shown larger on the opposite page, are three tiny instruments, one for measuring heat, one for testing air pressure, one for taking the force of the wind

WHAT TRAVELLERS SEE ABOVE THE CLOUDS

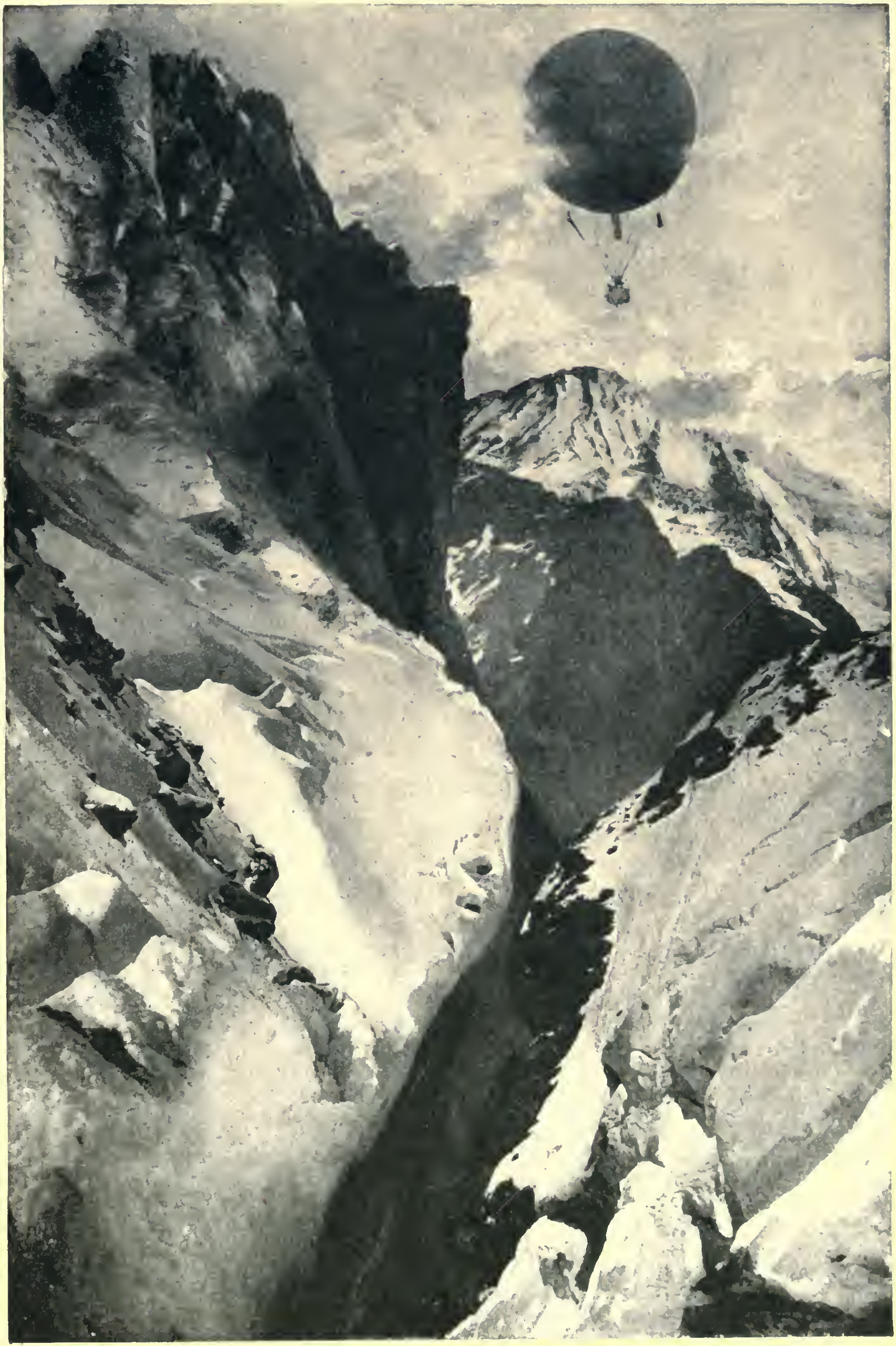


HIGH UP IN THE OCEAN OF AIR—SEA-CLOUDS ABOVE THE RIGI, IN SWITZERLAND



THE ROLLING CLOUDS THAT SWEEP ALONG LIKE WAVES OF THE SEA—A PHOTOGRAPH IN SOUTH CALIFORNIA

OVER THE ALPS IN A GAS BALLOON



ONE OF THE FIRST JOURNEYS ABOVE THE ALPS IN THE DAYS BEFORE THE AEROPLANE creeping over him, he had tried to open the valve to let the gas escape so that the balloon would fall into a denser level of air. But he, also, had lost the use of his limbs, and could not lift his arm to reach the cord. But, still fighting for a chance of life, he bit at the cord with his teeth, and managed at last to seize it and jerk his head downward, thus dragging open the valve

There was then a quick drop of some miles, during which Mr. Glaisher recovered completely, while Mr. Coxwell got back the use of his hands and continued to take scientific records. Both he and Mr. Glaisher estimated that during the period in which they were unconscious they had risen to a height of 37,000 feet.

THE INGENIOUS INSTRUMENTS BY WHICH MEN MEASURE THE CLOUDS AND STUDY THEIR HEIGHT ABOVE US

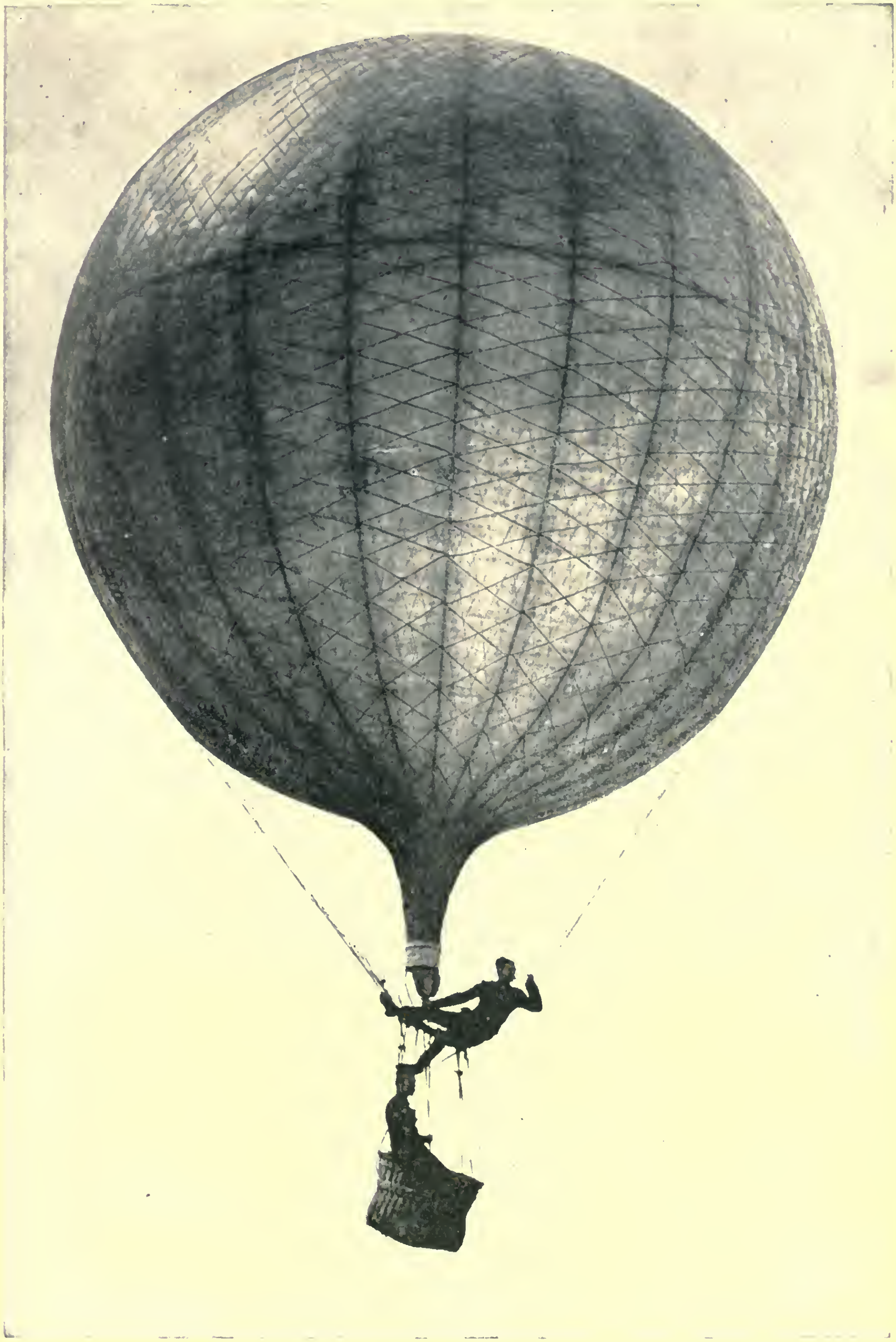
The striking photograph of the army balloon on page 219 was taken at Aldershot by Messrs. Gregory & Son; and the photograph of Trafalgar Square on page 221 was taken by Spencer Brothers.

This wonderful achievement aroused two French men of science to join in the work of exploration. They constructed a balloon called Zenith. It carried three small balloons filled with oxygen gas, which the explorers intended to breathe when they found the air too thin to support life. The two men of science, Tissandier and Crocé-Spinelli, entered the Zenith, accompanied by an experienced balloonist, Mr. Sivel. The car was filled with scientific instruments, and machines for taking observations and studying the heat, pressure, and vapour of the air. On reaching a height of 15,000 feet the voyagers began to breathe oxygen. Little discomfort was felt till they rose another 9000 feet, and then they all fainted. But the balloon must have fallen, for Tissandier revived, and found Crocé-Spinelli shaking his arm and shouting, "Throw out ballast!"

Staggering to his feet, Tissandier threw out pumps, overcoats, and everything he could lay his hands on, and what happened after that is not known, for all three lost their senses. With three unconscious men the great balloon rose higher and higher, beyond any height that had ever been reached before. When Tissandier again came to his senses, however, the balloon was falling at a frightful speed, and in the bottom of the basket his two companions lay rocking. They were dead. Tissandier himself came down alive, but nobody has since attempted to climb to such a tremendous height above the earth as the height at which these men died.

Men cannot exist there. It is a region of death. Yet such is the ingenuity of the human mind that the modern explorers of the ocean of air now know more about the atmosphere fifteen miles above our heads than the first balloonists knew about the lower layers of air. Finding it impossible to ascend safely themselves, men send up sounding balloons, filled with a troop of little mechanical slaves; or, in other words, they put machines into

THE WATCHER IN THE SKY: A SOLDIER'S LOOKOUT



"ABOVE ALL THE CARES OF THIS WORLD"—A WONDERFUL PHOTOGRAPH OF AN ARMY BALLOON specially constructed balloons, and set the balloons free to rise as high above the earth as the gas in their silken bags will carry them. The machines take the altitude and the temperature and the moisture of the upper air, and write the information faithfully down on sheets of paper, which are read when the balloon comes back to earth again. One instrument dips a gallon bucket into the aerial ocean, at a height of twelve miles, and then seals the bucket, so that the thin air can be quietly analysed in a laboratory and compared with the dense air that we breathe.

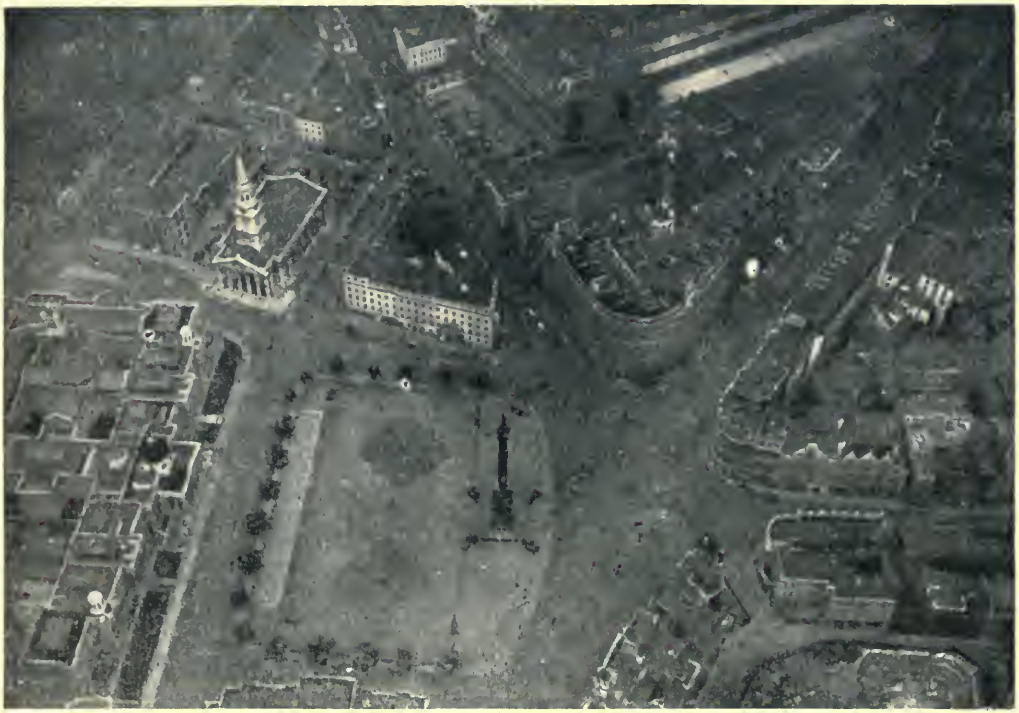
When the sounding balloons are ascending to their greatest heights their course is studied through telescopes, and a queer instrument, called a theodolite, measures their speed and height. By this means men are discovering the direction and strength of the mighty currents of air that sweep continually through the heavens.

LOOKING DOWN ON THE RHINE, THE GREATEST RIVER IN GERMANY, FROM A BALLOON

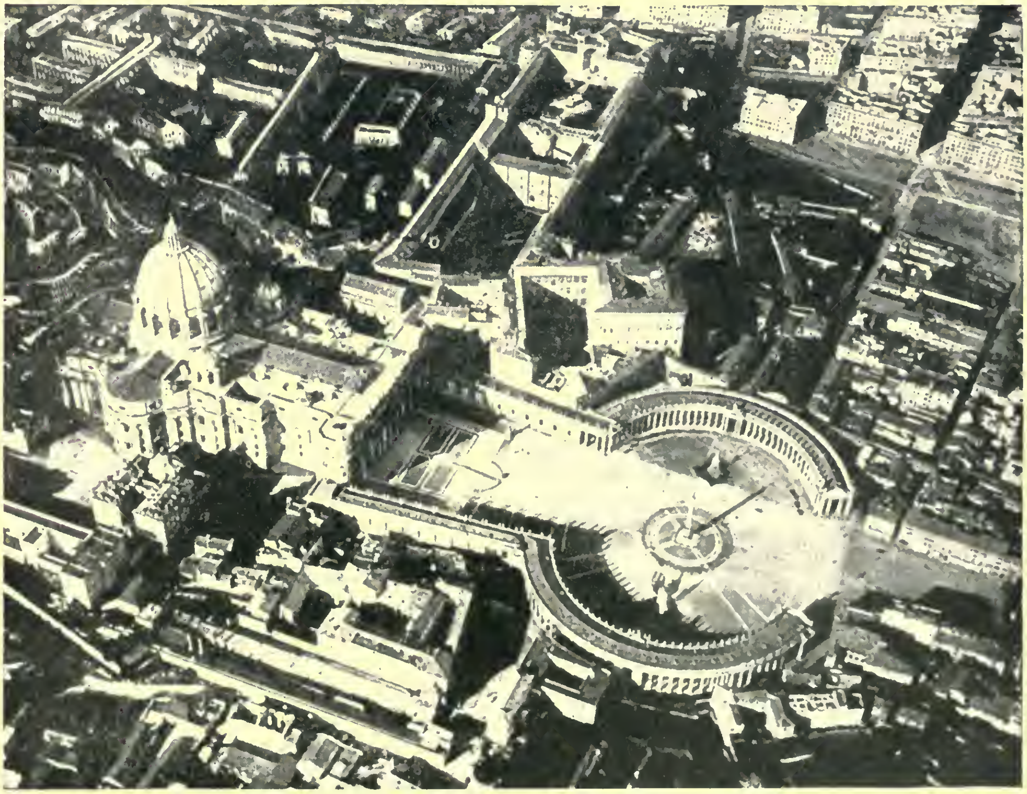
The Governments of thirty nations are now working together in exploring the ocean of air above us, and excellent work is being done at Pyrton Hill, in Oxfordshire, and other suitable places in Great Britain. Some of the work is being done to help airmen, and to provide them with more knowledge about the lower levels of air in which they fly, but the chief motive that urges on the little army of explorers is the disinterested pursuit of knowledge. They wish to know, for the sake of knowledge itself, the mysterious laws and properties of the sea of air above them. It is charged with strange electrical and magnetic power, which produces the gorgeous fiery spectacle of the Northern Lights that sweep in vast curtains of flame a hundred miles above the earth. Great winds, continually blowing at a hundred miles an hour, rage above the region of the highest clouds, and sometimes the temperature, instead of being always colder in the high air, tends to grow uniform, so that it is likely that the outer space between world and world is not so chill as was thought by the first explorers of the skies. Nor is it quite certain that the outer fields of space are a mere emptiness. Very light gases may rise up from our air and float away, and help, perhaps, to build up new worlds.

It may be that man will never be able to turn to practical use all the knowledge he obtains of the wonderful ocean at the bottom of which he lives, but he must go on with his work of exploration. He cannot rest contentedly on the floor of his sea, like a crawling crab, ignorant of what is happening above him, but ever seeks new knowledge.

LOOKING DOWN ON ROME AND LONDON

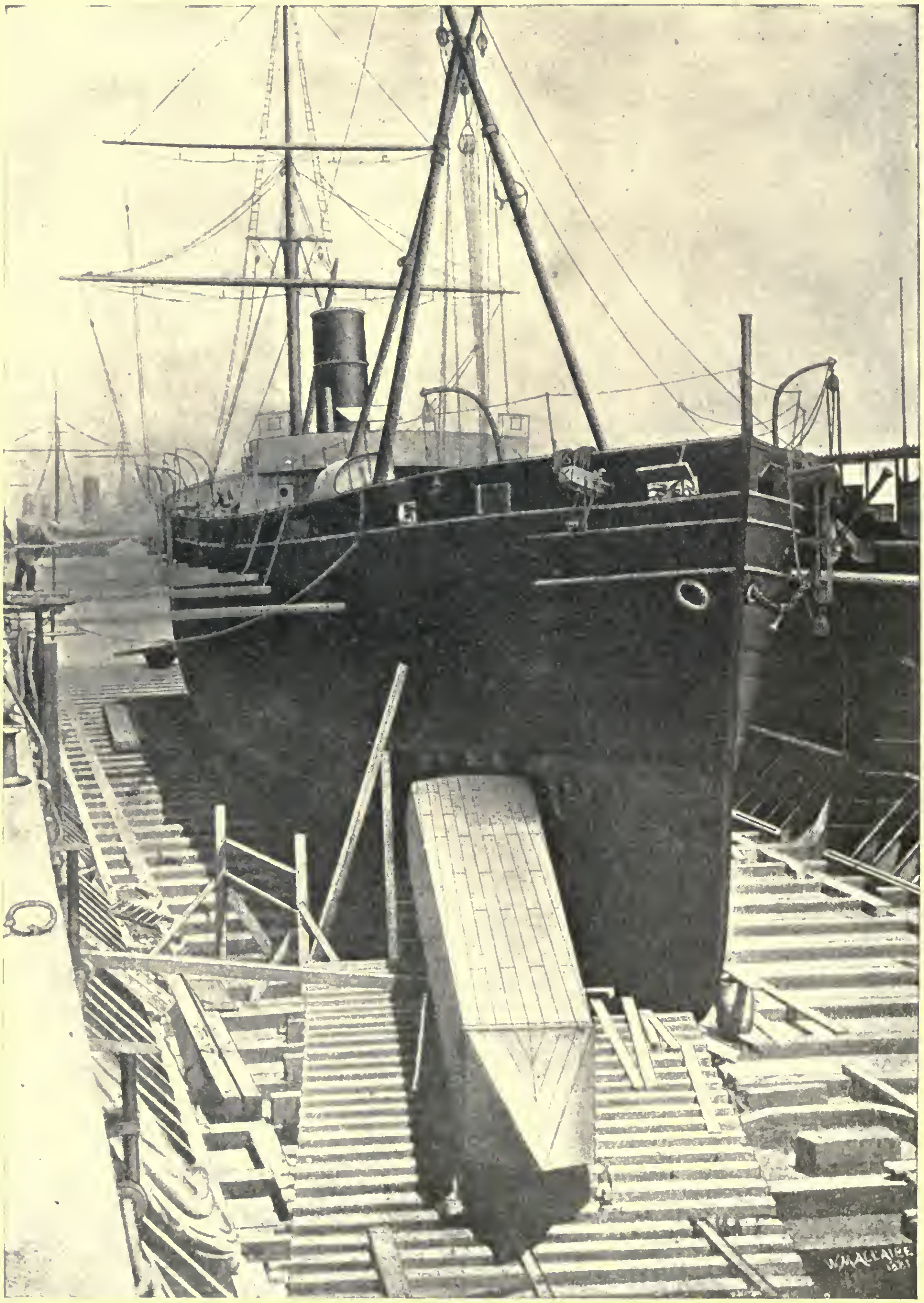


LONDON AS NELSON NEVER SAW IT—TRAFALGAR SQUARE SEEN FROM A BALLOON



ROME AS CÆSAR NEVER SAW IT—ST PETER'S SEEN FROM A BALLOON

THE EMBARKATION OF CLEOPATRA'S NEEDLE



This is the "Dessoug," the ship in which Cleopatra's Needle was brought to America. When the obelisk was presented to the United States, the government was confronted with the problem of how to convey it from Alexandria to New York. This shows how the problem was solved. A water-tight box was built around the Needle, it was floated down the harbour to the docks, and loaded on the "Dessoug" through a great square hole cut in the bow of the vessel. When the Needle had been hauled into place, the hole was carefully closed up, and the vessel sailed away with its odd cargo. This is probably the only time on record when the hold of a ship was loaded in dry dock, through a hole below its water line. You can see the hauling tackle above the side of the ship.

Alexandria, where Cleopatra's Needle stood. The prostrate one beside it is the London obelisk.

OBELISKS THAT MOSES SAW

THE obelisks that were erected at Heliopolis 3500 years ago, and for almost nineteen centuries stood side by side overlooking the sea at Alexandria, are now 5000 miles apart. One stands in Central Park, New York, and the other on the Thames Embankment, London.

Looking at the New York obelisk, it is hard to realise that it belongs to ancient times, for its gilded cap and smooth surface give it quite a modern appearance. The zinc cap was added in 1914 to preserve the top of the obelisk. At the same time the granite shaft was treated with a chemical preparation, which made the surface air and water proof and rendered it hard and elastic, so that it resists the friction of sand and dust and the sudden changes of temperature. A similar attempt was made to protect the monument from the forces of the weather in 1885, shortly after it was erected, when it was observed that the granite decayed rapidly and fell off in flakes.

The obelisk was one of the earliest forms of sculpture in Egypt. The Egyptian kings claimed, during their lives, to be gods, and these obelisks were columns on which were inscribed their titles and a record of their virtues and achievements. They were set up at the entrance to temples, where various idols were worshipped. Cleopatra's Needle was one of two such obelisks set at the entrance to the great temple of the sun at Heliopolis, or "City of the Sun," formerly called On, the seat of the Pharaohs, and the centre of learning. The columns were set up by Thothmes III., about 1500 years before Jesus was born. Up the centre of the sides of the column the titles of Thothmes were carved. The column stood for 200 years untouched. Then Rameses II. came to the throne of Egypt, and he in turn had his titles carved on it. As the inscription of Thothmes ran up the centre of the column, Rameses had his carved at the sides, leaving the founder his place in the centre of each face of the obelisk.

The most interesting part of the obelisk's Egyptian career to us is that part in the reign of Rameses II. He was a powerful king, who was a great builder. There were living in his land a great many people who were not of his nation. They had been there a long time, and had been protected, but they were now out of favour. As Rameses did not make war and exact tribute from conquered enemies, money became scarce for his building, so he gladly imposed hard conditions upon the strangers. He took from them their flocks and herds and lands; he made them slaves, he made them labour upon his works. Can we guess who these people were, upon whose sufferings Cleopatra's Needle looked down? They were the Israelites.

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In spite of all their sufferings, the Israelites increased in numbers, and Rameses, fearing that they might rise in rebellion, ordered that all their male infants should be slain. It was at this time that there was born a little Hebrew boy named Moses. He would have had to be slain had the law been obeyed, but his loving sister hid him in a cradle, which she placed among the rushes by the river's brim. Who should come there but Bint-Anat, a beautiful princess, the best-loved daughter of Rameses, or Pharaoh, as he was called? She rescued the child, had it taken home, and educated in the royal palace.

IF CLEOPATRA'S NEEDLE COULD SPEAK!

Heliopolis was then the greatest centre of learning in the world, and in the shade of the great monoliths Moses played and was taught all that the greatest scholars of the age could teach him. Every child knows the rest of the story—how Moses, knowing that he himself was a Hebrew, slew an Egyptian whom he saw ill-treating an Israelite, and had to flee from the wrath of the Egyptian king.

Rameses was the wicked Pharaoh with whom Moses had the long struggle for the release of his people. All this wonder and tragedy this pillar of granite, now looking down upon the Thames, witnessed in those wonderful Egyptian days. If it could but speak, and tell us the things it has seen! It would tell us of the famine years in Canaan, when Abraham took refuge in Egypt. It would tell us of the imprisonment and slavery of Joseph, of his later prosperity and marriage with Asenath, the daughter of Potipherah, priest of Heliopolis. It would tell us of that wonderful meeting between Joseph and Jacob, and the tale of the boyhood of Moses.

But there, overlooking the Nile, it stood, while the wars and changes of the world went on. Century after century passed away, and a new queen of beauty arose. Her name was Cleopatra, and her extraordinary life was lived just before Jesus came into the world.

IN MEMORY OF JULIUS CÆSAR

Alexander the Great had lived and won the whole world, but had passed away, leaving his name for ever in a city of Egypt, named after himself, Alexandria. There the beautiful Cleopatra made herself a palace of unsurpassed splendour. She meant to have these two obelisks carried down, hundreds of miles away from Heliopolis, to be placed in front of it. But she died before the work was carried out, and Cæsar Augustus himself had them brought down the Nile, and placed in front of a building erected to honour the memory of Julius Cæsar. The obelisk, when first carved, was cut out of the solid rock and floated down the Nile on rafts to Heliopolis; it was floated down, fifteen centuries later, to Alexandria, and there it rested for another eighteen centuries.

The two obelisks were set up, but about 300 years ago one fell. It lay in the sand, and was covered deep with rubbish till the beginning of the nineteenth century, when the ruler of Egypt offered it to the British Government. The other obelisk was given to the American Government, and now stands in New York. Not until 1877 did England see the wonderful obelisk known as Cleopatra's Needle.

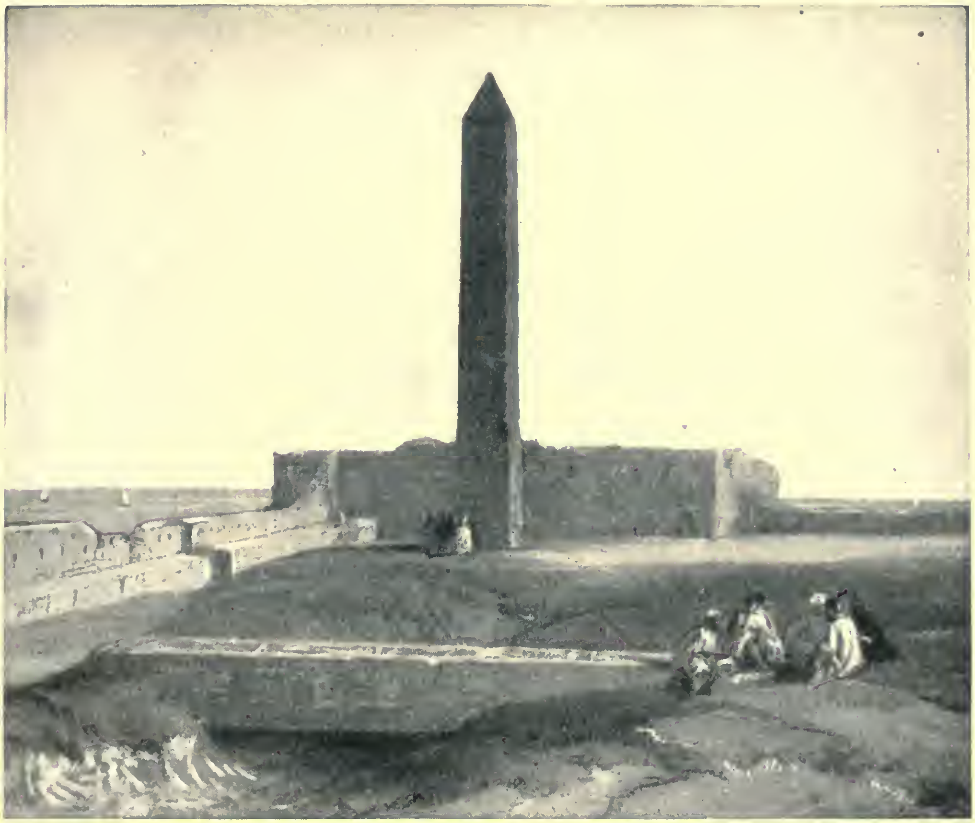
Then it was a private citizen, not the Government, who had brought it over. Sir Erasmus Wilson, a famous doctor, offered a shipowner $50,000 to bring the obelisk over. It was no light task. The column is 68½ feet in length, and weighs 186 tons. A great steel tube was built round the column. The tube, or cylinder, was really a ship, but it had only the obelisk for its interior. When all was ready it was dragged into the water, and towed by a steamship called the Olga.

LOST AND FOUND AT SEA

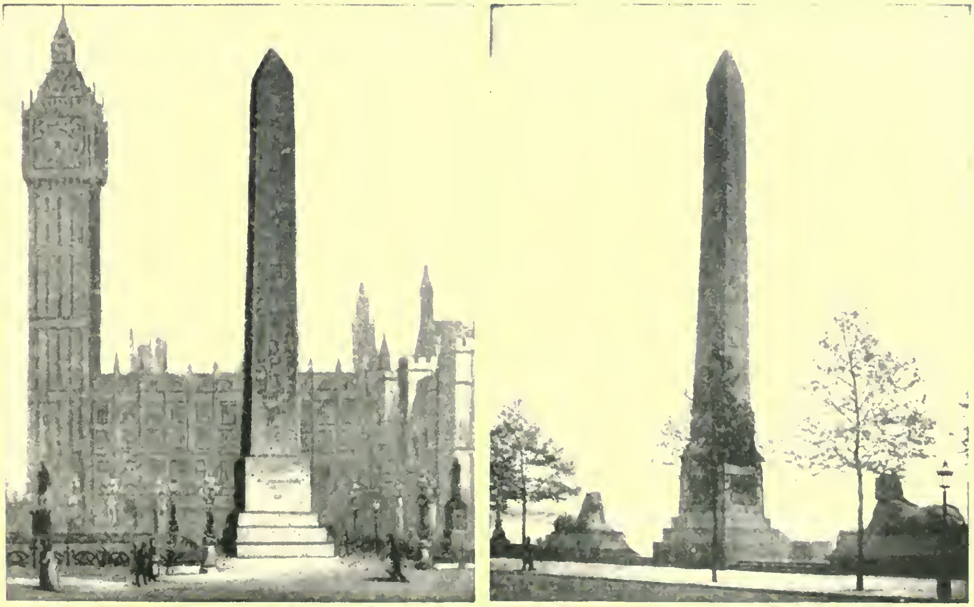
The latter drew the Cleopatra, as the cylinder-ship was called, by a great steel cable a quarter of a mile in length. In the Bay of Biscay a terrible storm swept down. The Olga could not fight against it and haul the Cleopatra too, so a signal was given to cut the cable. This was done; but there were eight men aboard the Cleopatra. A boat was sent off from the Olga to rescue them, but the sea carried the boat away, and the six men in it were drowned. Later efforts were made, however, and the crew were all safely taken off the Cleopatra, which drifted out of sight. The great column which had looked down on nearly two thousand years of Bible history was afloat, at the mercy of the waves.

A day or two later another steamer, when the storm had gone down, found the Cleopatra, and its captain took it in tow, wondering what he had found. It was taken safely to London, where the finder was rewarded with $1,000. After much dispute as to a site, the column was set up on the Embankment.

ALEXANDRIAN OBELISK IN EGYPT & IN LONDON

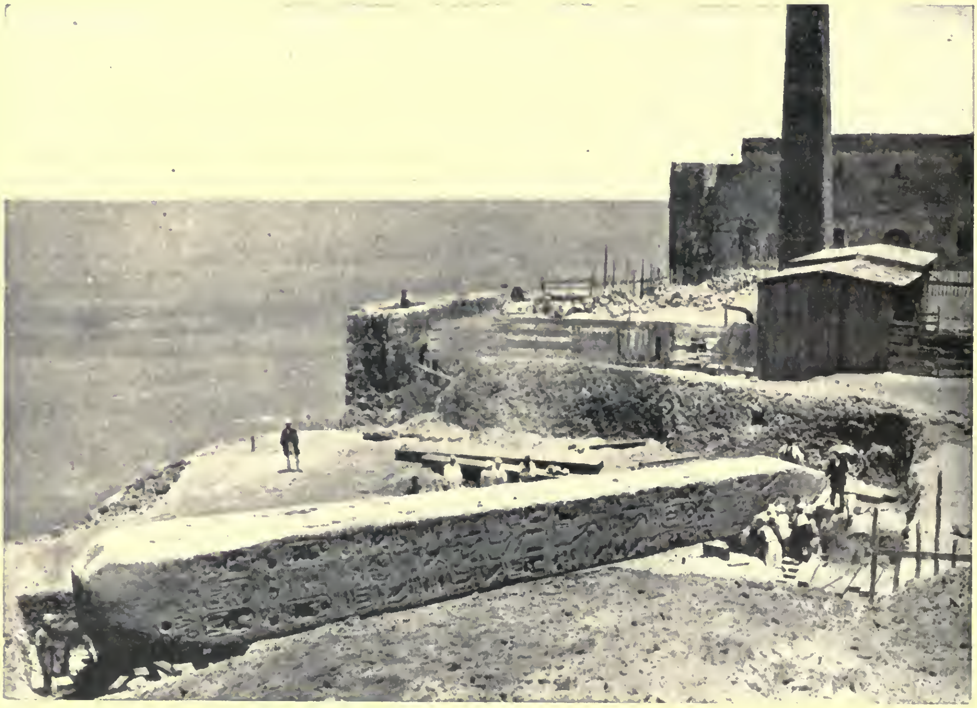


The two obelisks in the picture were carried to Alexandria nearly 2,000 years ago. The one standing, commonly called Cleopatra's Needle, is now in Central Park, New York. The prostrate one, which lay in the sand for 300 years, is now on the Thames Embankment, London.

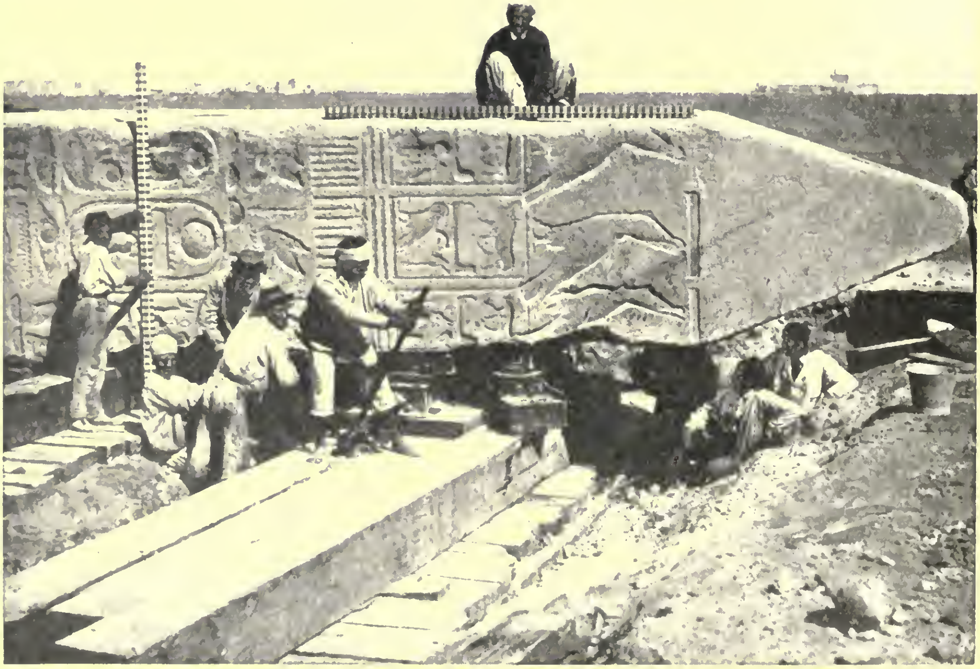


After the arrival of the obelisk in London, one of the sites suggested for it was in front of the Houses of Parliament The left-hand picture shows how it would look there, and on the right we see it as it is on the Embankment.

THE OBELISK AS IT LAY FOR 300 YEARS

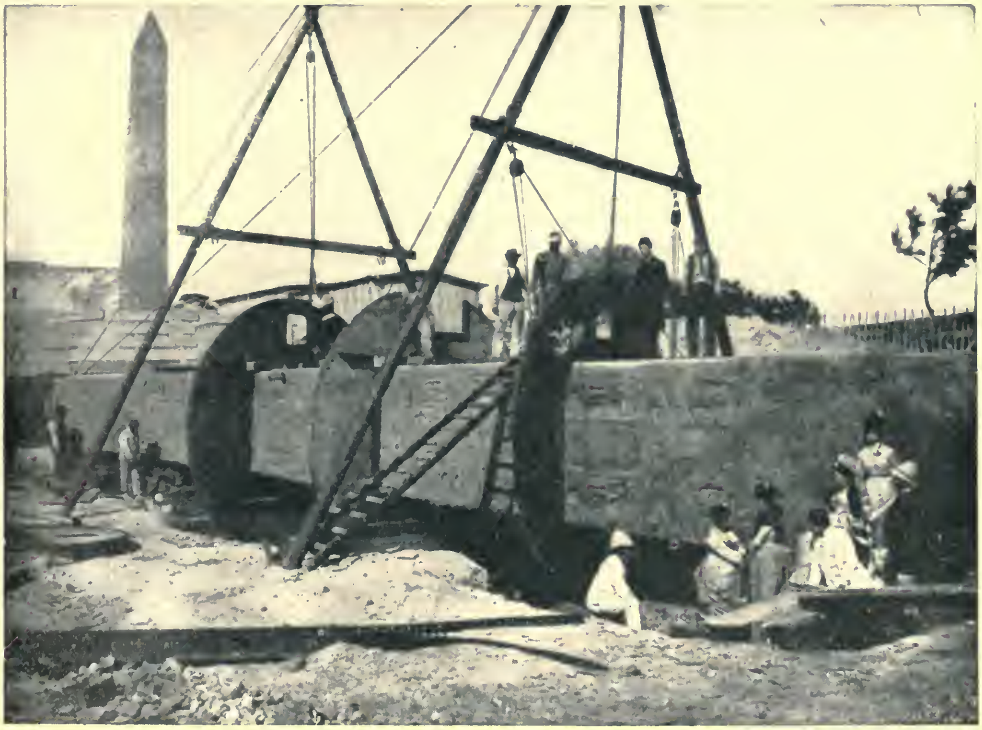


Originally set up at Heliopolis, the On of the Bible, Cleopatra's Needle is fifteen hundred years older than Cleopatra's time. It was the Emperor Augustus who removed the pillar to Alexandria, and he erected it in front of his palace.

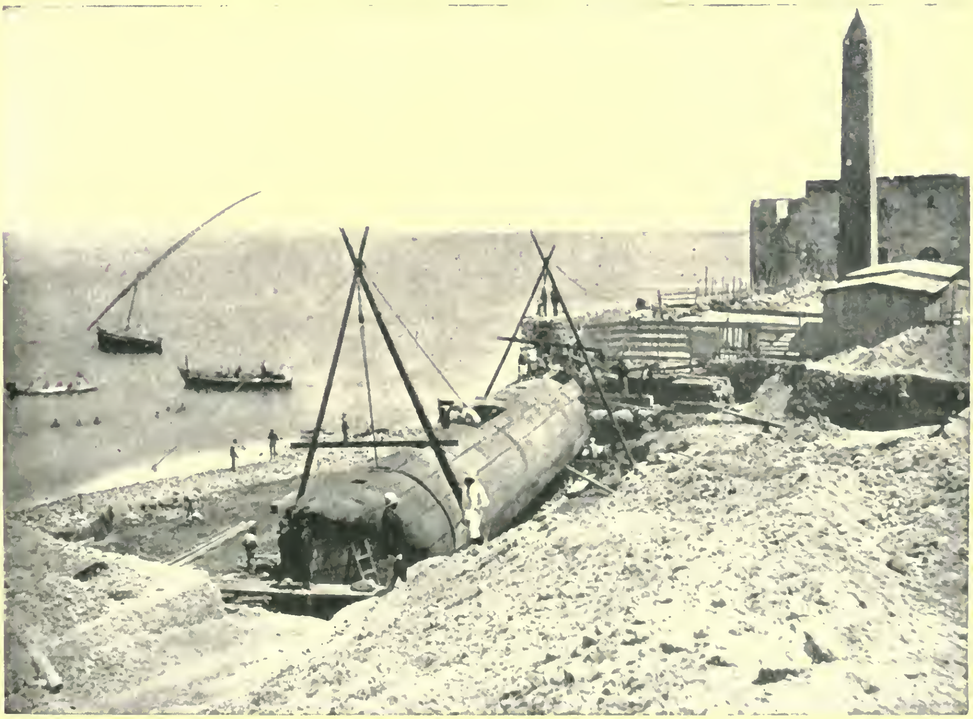


Mahomet Ali, the ruler of Egypt, offered the fallen obelisk to George the Fourth, but the offer was declined, and only in 1877 was the obelisk brought to England. Here it is being raised so that an iron case may be built round it.

PUTTING THE LONDON OBELISK IN A CASE

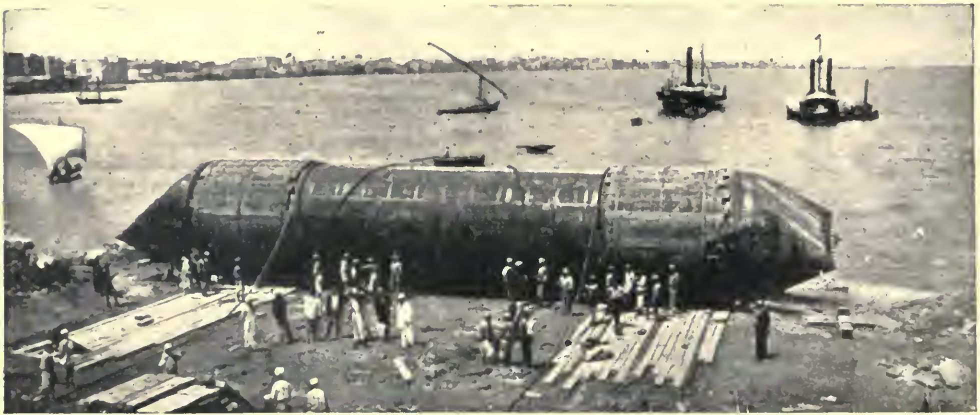


A metal case for the obelisk was designed and made in England, and was sent out in pieces to Egypt. This was riveted round the obelisk, as seen in this picture, and timber cushions were placed inside to protect the obelisk.

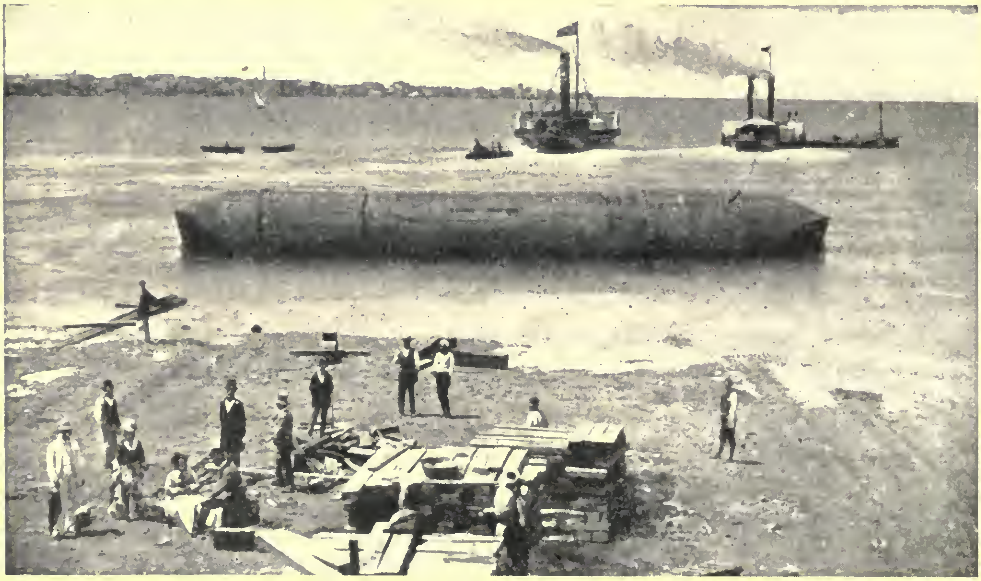


Here the obelisk is packed ready for launching. The greatest care had to be taken to fix the obelisk in the middle of the case, so that with the rolling of the waves it should not be knocked against the sides and seriously damaged.

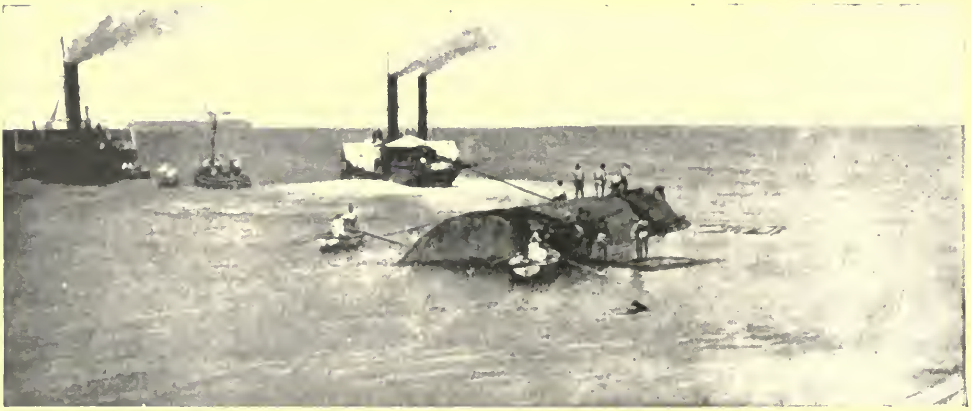
THE OBELISK BEGINS ITS LONG VOYAGE



When the case was all ready for launching, large wooden wheels were put on the two ends, and planks were laid for it to roll upon. It took more than two days for tugs to pull the case by means of wire ropes to the water's edge.



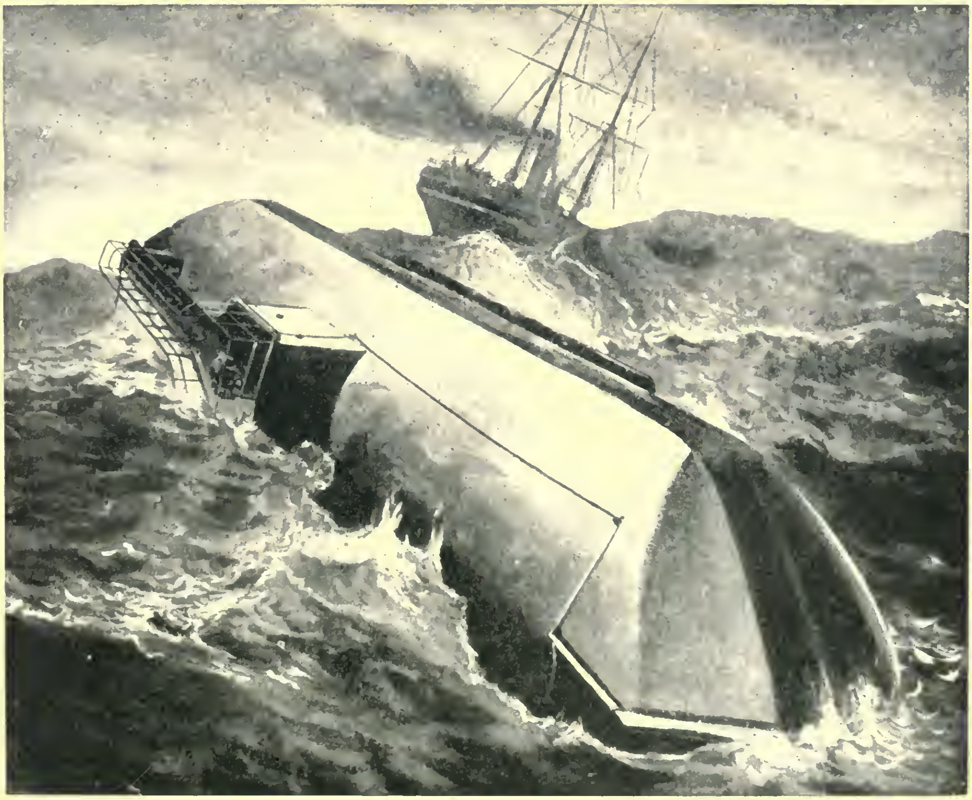
At last, when the case was pulled into the water, it remained immovable; and divers discovered that a great stone weighing half a ton had pierced the case, which was full of water. Several days were occupied in repairing the case.



When the case was mended, the curious-looking craft was floated and towed into harbour, so that a cabin-house and rail, and a mast, rudder, and keel could be fixed in position. This was the beginning of the obelisk's long voyage.

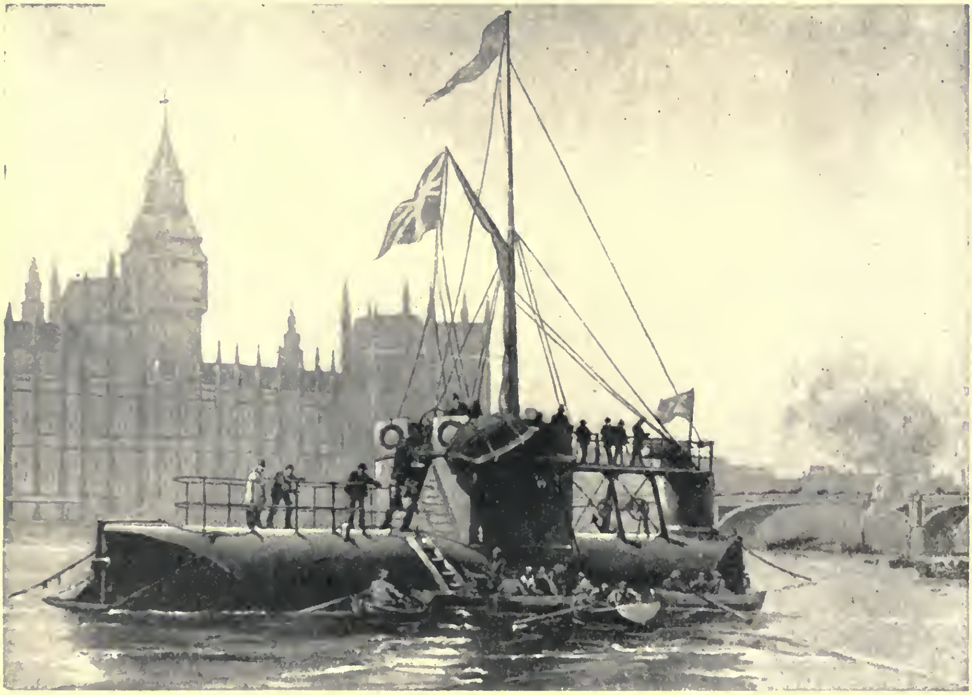
A STRANGE WRECK IN THE BAY OF BISCAY

The case, which was now a vessel, was named Cleopatra, and left Alexandria on September 21, 1877. It was towed by a steamer, but during a storm in the Bay of Biscay the Cleopatra was cut adrift and her crew rescued

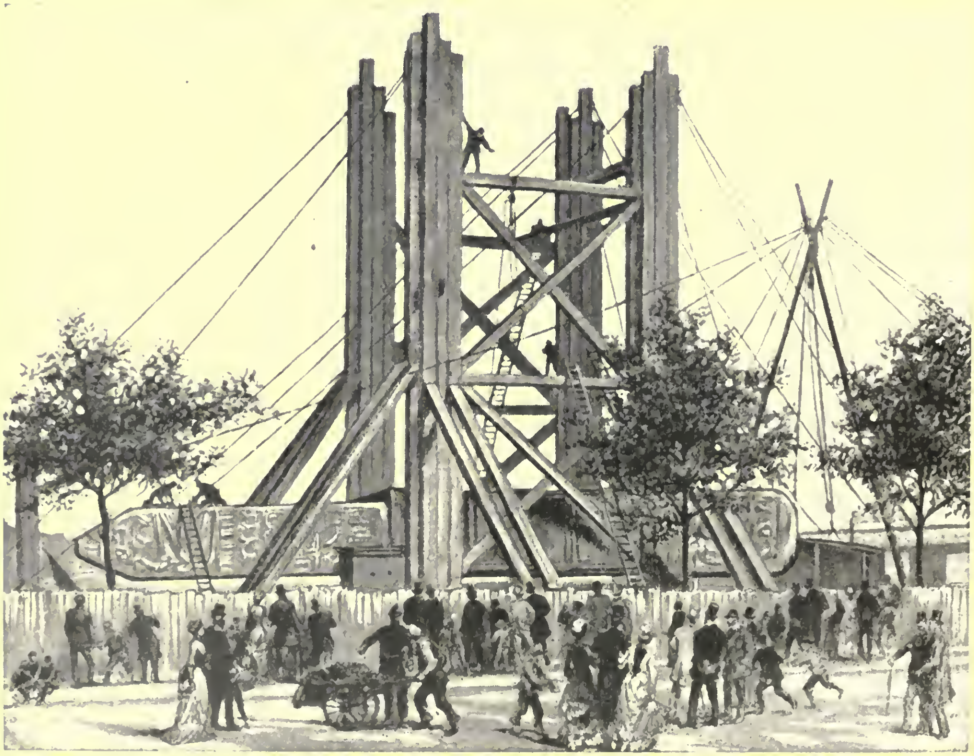


The Cleopatra had lost her mast and turned over before her crew was rescued. The storm continued, and before long the obelisk was lost, but two months later it was found again and towed to Spain, and later on to England.

THE OBELISK REACHES LONDON AT LAST

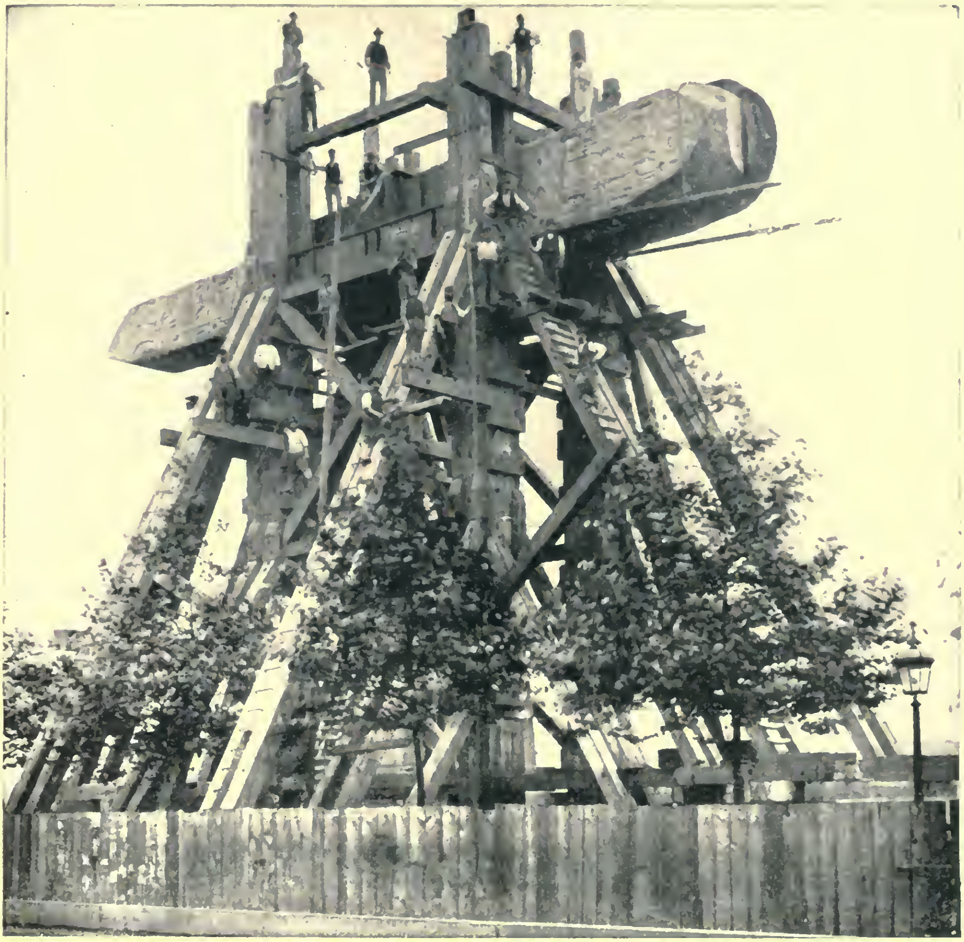


At last, after its long and adventurous journey, the obelisk arrived safely in the Thames, and was moored at Westminster Bridge, where it became an object of great interest to the people of London as it lay encased in its iron sheath.

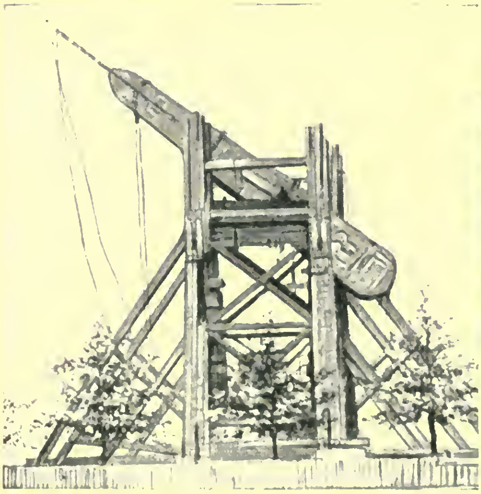


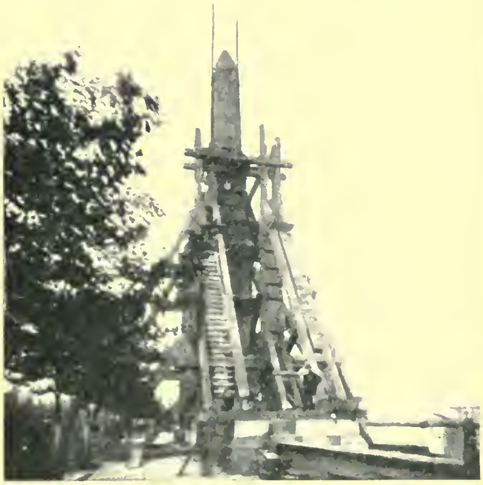
The work of erecting the obelisk on the Victoria Embankment was not easy. An iron jacket had to be fitted round it, and this had two trunnions, or pivots, upon which the obelisk could be turned easily. Then a wooden scaffold was built

THE OBELISK IS SET UP ON ITS PEDESTAL



The obelisk was raised horizontally until it was fifty feet above the grey granite pedestal that had been prepared for it. The trunnions rested on iron girders, and the engineer's plan was to swing the obelisk round into a vertical position.





On the left we see the obelisk being swung round on the pivots. As soon as it was upright over the pedestal it was let down on to the granite base, as shown on the right. The operation of swinging took three-quarters of an hour.

"CLEOPATRA'S NEEDLE" IN NEW YORK.

The American Obelisk, also commonly called "Cleopatra's Needle," had a less adventurous voyage than its companion, but its transportation to its present site was attended with many difficulties.

TRANSPORTATION.

The obelisk was covered with planks, kept in place by iron bands, to protect the inscriptions. As the city of Alexandria would not allow the obelisk to be taken through its paved streets to the harbour, the obelisk was enclosed in a caisson, or water-tight box, and floated to the dock. There the Dessoug, bought from the Egyptian Government, was specially prepared to receive it. A large hole was cut in the bow, and the obelisk was pushed through it into the hold of the vessel. The pedestal and foundation stones were placed on the deck. Then the hole was repaired; and on June 1, 1880, the vessel steamed out of the harbour, bearing the obelisk to its new home.

On July 19, 1880, the Dessoug reached New York. The site opposite the Metropolitan Museum of Art, in Central Park, had already been selected. But, as it was quite a distance from the water front, the problem of transporting the monument there was a most difficult one.

The pedestal and foundation stones were landed at Fifty-first Street and North River, and put on a truck drawn by thirty-two horses, and hauled over to Fifth Avenue and Eighty-second Street, then moved on greased skids to the site.

But the landing of the obelisk was a more perplexing problem, and a month passed before a suitable dock was found. On August 21 the Dessoug's bow was hauled out of the water on the east shore of Staten Island. The hole in the bow was reopened, and the obelisk was hauled out and placed on a landing-stage, under which two pontoons were placed. As the tide rose it lifted the pontoons and the cross-timbers supporting the obelisk off the piles. At high tide the pontoons bearing the obelisk were floated into the bay, and towed to the foot of Ninety-sixth Street by the steamer Manhattan. There a similar landing-stage had been erected. While the tide was still high, the pontoons bearing the obelisk were placed in position between the piles of the landing-stage. Then water was pumped into the pontoons so that they sank, and the obelisk was soon safely landed on Manhattan Island.

Then the long land journey began. By means of portable tracks, the obelisk was slowly moved to its destination. To avoid delaying the traffic on the New York Central Railroad, a temporary bridge was built, and the crossing made in less than two hours. Then the obelisk proceeded on its way across New York to its final resting place, where it was set on the pedestal on January 22.

INSCRIPTIONS.

Underneath the lower edges, which were broken, were placed four bronze crabs, cast in the Brooklyn Navy Yard in imitation of the original crabs found under the obelisk at Alexandria. The two original crabs are now in the Metropolitan Museum of Art, New York.

On the eight claws of the four crabs are the following inscriptions:

First crab, first claw:

On one side a Greek, and on the other a Latin inscription, both telling the same story, which has been translated as follows:

Barbarus, Governor of Egypt, erected this obelisk in the eighteenth year of the reign of the Emperor Augustus (12 B.C.). Pontius was the architect.

First crab, second claw—

Quarried at Syene, Egypt; erected at Heliopolis, Egypt, by Thothmes III. in the sixteenth century B.C.

Second crab, first claw—

Removed to Alexandria, Egypt, and erected there B.C. 22 by the Romans.

(This date should be B.C. 12.)

Second crab, second claw—

Removed to the United States of America A.D. 1880, and erected in New York City, January 22, 1881.

Third crab, first claw—

Presented to the United States Government by Ismaïl, Khedive of Egypt.

Third crab, second claw—

Rutherford Burchard Hayes, President. William Maxwell Evarts, Secretary of State of the United States.

Fourth crab, first claw—

The cost of removing from Egypt and placing on this spot this obelisk, pedestal and base, was borne by William H. Vanderbilt.

Fourth crab, second claw—

Lieutenant-Commander Henry H. Gorringe, United States Navy, designed the plans for and superintended the removal and re-erection.

PRESENTATION OF THE OBELISK.

On February 22, 1881, the obelisk was formally presented to the City of New York with appropriate ceremonies,

HOW THE TAPESTRIES ARE MADE

THE STORY OF ONE OF THE RICHEST AND MOST BEAUTIFUL CRAFTS STILL LEFT IN THE WORLD

WEAVERS OF WONDERFUL VISIONS IN AGES LONG AGO

ALL of us are, in a way, weavers of tapestry. Young and old, we stand working at the loom of time, weaving the storied pattern of our lives. We cannot tell exactly what kind of picture we are making out of the hundreds and thousands of things that enter into our existence. Most of us, no doubt, work to some sort of rough design, but we cannot see what the complete effect will be.

The tapestry-maker labours in the same way. His most beautiful pictures are made by him without his seeing them, for he stands behind his loom and not before it. That is to say, he labours on the wrong side of the tapestry, putting in thousands of different coloured threads and weaving them together into some wonderful vision of flowers and trees and figures which he cannot see. He must leave his place and walk round to the front of the loom to see the work he is doing.

At the famous Gobelins, where French tapestry is made, each weaver works three hundred days in the year, and in these three hundred days he produces less than one square yard of tapestry. Eleven square inches is, in fact, a record day's work, and the cost in wages alone of making a yard of tapestry is over $400. It is no wonder, therefore, that good tapestry is very costly. A large modern design is worth $8000 and over, while the masterpieces fetch anything from $300,000 up.

These prices are not of modern growth. In the days when ancient Britons were still painting themselves with woad, rich men in the Roman Republic were giving $35,000 for single pieces of tapestry taken from the temples and palaces of Babylon. Two hundred years later, in the reign of Nero, the same hangings were bought by the Emperor at double the price. Three thousand years before our era, the ancient Egyptians wove tapestries on the same kind of loom now used at the French Government manufactory at the Gobelins in Paris, and many examples of their art have been recovered from ancient tombs.

Races as savage as the Red Indians of America knew how to make tapestry, and all the great civilisations of the world have promoted the art of weaving coloured threads into designs and pictures that were hung round the halls and rooms to keep out the draughts and delight the eyes of the beholders. It is only since wallpapers came into general use in Europe that the tapestry-weavers have sadly diminished in number. Most of their descendants are now employed in carpet-making. But in a few places in Europe the more beautiful and delicate art of weaving picture-hangings is still carried on. In Asia there are many tapestry-makers who produce richly coloured and valuable work.

But what lovers of beautiful and romantic things prize most are the tapestries of the days of chivalry. In the grim fortresses of the Middle Ages the cutting draughts were severely felt, and hangings were used to hide the bare stone walls and cover the doorless entrances to rooms. In country manor-houses, and in the dwellings of town merchants, the use of beautiful tapestry became a necessity rather than a luxury, and churches also kept the tapestry-makers very busy. The woven hangings were the picture-galleries of the people. They were the records of the time, representing the legends of popular saints and the lives of warriors and ladies famous in the stories told around the hearth in winter. On festive occasions in the great towns, the streets were adorned with draperies of gold and silk and pictured hangings. Whenever there was a kingly reception or a solemn religious ceremony, it was sure to be accompanied by a display of the richest tapestries. Unfortunately, very few of these old hangings have come down to us, and so rare are they that they bring greater prices than the pictures by the most famous old painters. $500,000

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would not buy some of the finest pieces of tapestry that are now in existence.

In the old days Englishmen were renowned as tapisers. In 1371 the King of France hung some of his rooms with English tapestry. But the little Flemish town of Arras was for many years the most famous centre of tapestry-making, and the term "arras" is still often used for tapestry. When the Sultan of Turkey captured the son of the Duke of Burgundy, in 1396, he could have obtained a great amount of gold as a ransom, but the Sultan asked only for "some tapestries worked in Arras, representing good old stories." Thus we see how widely and highly esteemed were the pictures woven in the little Flemish town.

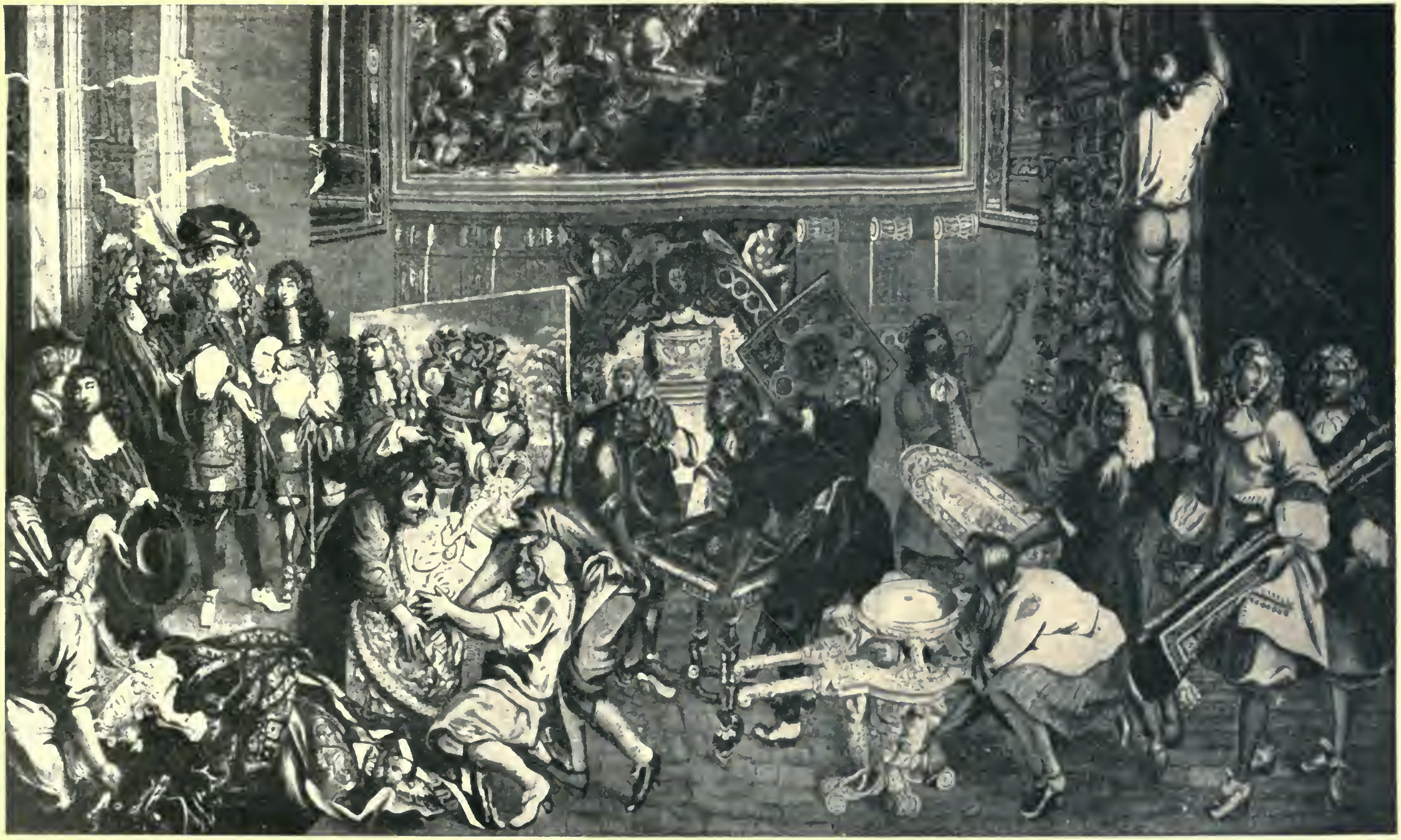
A TAPESTRY OF PAUL AND BARNABAS AT LYSTRA, WHERE THEY PREACHED ON THEIR MISSIONARY TOUR

Unhappily, the skilful Flemings were attacked by the French in 1477, and their town was destroyed and annexed to France. Many of the weavers fled to Brussels, and made this city the new centre of tapestry-making. At the present time it is the old tapestries of Arras and Brussels and other Flemish towns which are most sought after, and the finest work is now in the royal palace at Madrid, where it was carried when the Kings of Spain became masters of Belgium, and acquired the splendid tapestries of their new kingdom.

All the greatest artists of Europe were proud to help the Flemings in their work. Some of the finest pictures in England are really cartoons drawn by the great artists of Italy to be woven into picture-hangings for popes, kings, and princes. For instance, at Hampton Court is the famous picture of the "Triumph of Julius Cæsar," and at South Kensington Museum are the splendid cartoons which Raphael drew for the Brussels weavers by command of Pope Leo X. There were ten tapestries illustrating the Acts of the Apostles, for which Raphael received $10,000 for his part of the work, while the master weaver, Peter van Aelst, was given $150,000. The tapestries still hang in the Vatican at Rome. After the death of Leo X. they were pawned for $50,000; six years later some of them were stolen and cut into pieces during the sack of Rome. Some of the pieces were found in Constantinople, and brought back to the Vatican, and then, during the French invasion of Italy under Napoleon, the wonderful hangings were taken to France and exhibited in the Louvre. About a hundred years ago the Pope once more recovered them, and hung them again in the Sistine Chapel.

There are, however, some of these tapestries of Raphael's design hanging still in beautiful old country houses of England. In 1619 some skilful tapestry-makers from Flanders settled at Mortlake on the Thames, and established the art there. Rubens and Vandyke painted designs for them, and

A PICTURE IN TAPESTRY OF THE MOST FAMOUS TAPESTRY WORKS IN THE WORLD



A TAPESTRY MADE AT THE FAMOUS GOBELINS WORKS IN PARIS, SHOWING KING LOUIS VISITING THE WORKS ABOUT 250 YEARS AGO their work became famous throughout the world. Even at the Gobelins in Paris, where some Flemish weavers also settled, no tapestries were woven of such loveliness as those which came from Mortlake. But in the wars and revolutions of the seventeenth century the art of tapestry-making again perished in England, and for nearly two centuries the French weavers in Paris alone kept alive in Europe the highest traditions of the most ancient, as well as the most beautiful, of weaving crafts.

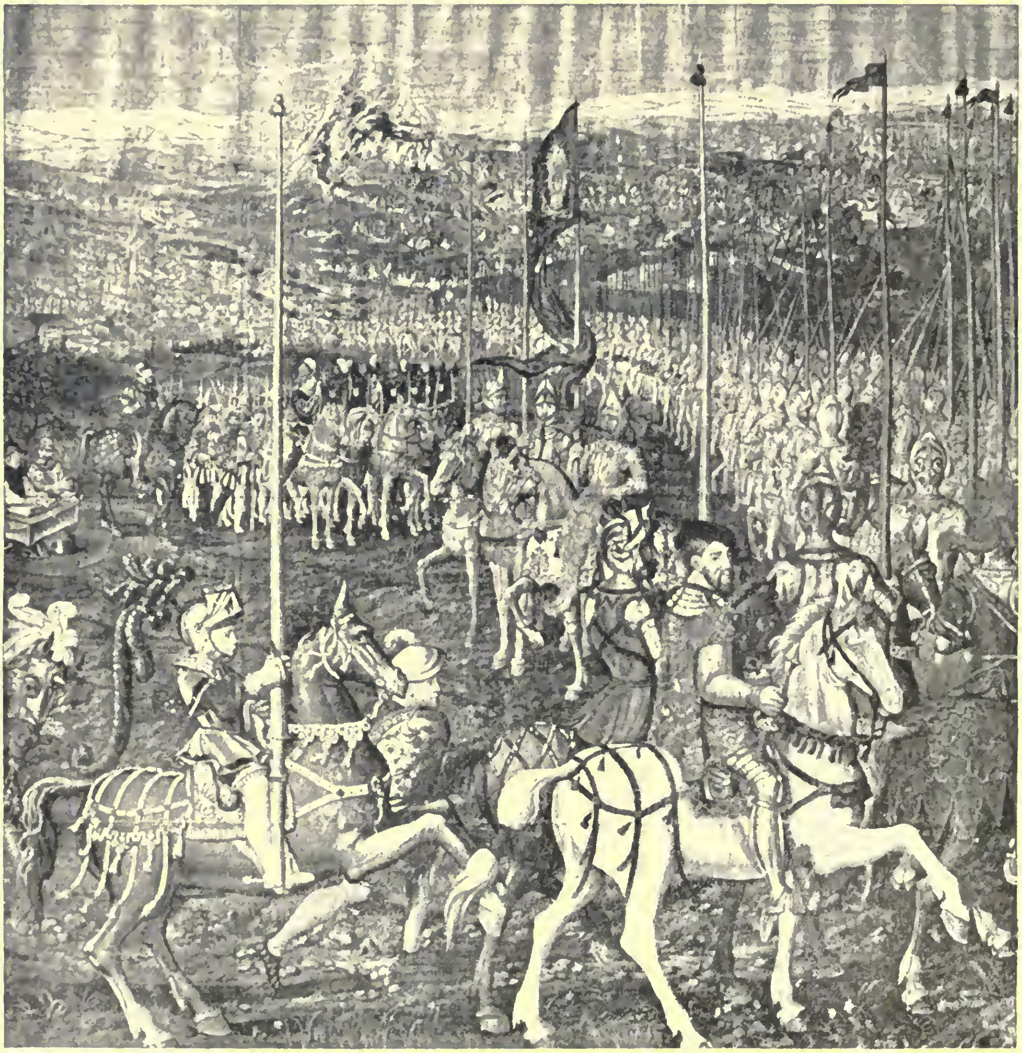
A BEAUTIFUL TAPESTRY OF THE BIRTH OF JESUS—FROM A DESIGN BY SIR EDWARD BURNE-JONES

Tapestry is really the most primitive art of weaving. In various remote parts of the world there are still races of savages who make their cloth in much the same way as a tapestry-weaver makes his splendid pictured hangings. The loom consists of two upright pieces of wood, at the top and bottom of which are two wooden rollers. The two rollers—which at first were merely the smooth trunks of young trees—serve to hold the ends of a longish row of threads. These threads form the warp of the material which is to be made. Both the savage weaver and the modern tapestry craftsman proceed in the same way. They pluck each thread apart from the others and insert another thread under it and over the next warp thread. So they make a crosswise weft running through the lengthways warp. At some far distant date in the history of mankind it struck some primitive weaver that he could produce a pretty effect by inserting coloured weft threads into his warp, and thus making designs in colour in the finished fabric. This was the origin of tapestry. The work is still done in the same laborious way as in primitive times. Having stretched his white warp threads on his two rollers, the weaver takes his stand behind his loom, and begins to tie bits of coloured thread to the warp, and weave them into patches of colour. The workers at the Gobelins have fourteen thousand different threads to choose from in making their pictures. They study the cartoon drawn for them by some distinguished painter, and see what colours they need, and then carefully select the tinted threads from the store. Each piece of coloured thread is wound on a peg. To use it, the weaver pulls some strings hanging from his loom. These strings are looped round the warp, and by pulling them a part of the warp is brought forward so that the coloured thread can be passed in and between the threads of the warp. In this way a tiny spot of colour is woven into the material. So the weaver goes on building up the picture, thread by thread. At his back is the design he has received from the painter; at his side are his pegs of coloured thread; before him is the wrong side of the tapestry, with many pegs of thread hanging from the places where they were last used; and on the other side of the loom, where he cannot see it, is the picture he is weaving. Yet he seldom makes a serious mistake, for he knows from long experience and training how to get the unseen effects at which he aims. Every now and then he drops his work, and walks in front of the loom to see how he is getting on.

THE OLD TAPESTRY PICTURE BY THE WIFE OF WILLIAM THE CONQUEROR—A FRAGMENT OF THE FAMOUS BAYEUX EMBROIDERY, REPRESENTING HAROLD ALARMED BY THE APPEARANCE OF HALLEY'S COMET

There is an easier way of making tapestry, by means of treadles that move the warp threads, but in the finest work everything has to be done by hand. Some years ago an English poet, William Morris, taught himself to make the best kind of tapestry and then trained some workmen at a little manufactory at Merton. Six of the Merton hangings, after designs by Sir Edward Burne-Jones, were sent to the Paris Exhibition of 1900. The French at once recognised that a formidable rival to their workmen at the Gobelins had arisen, and a grand prize was given to the English tapestry-makers. Tapestry is also being made in Ireland now, and it is hoped that the revival of the craft may eventually develop into a national industry.

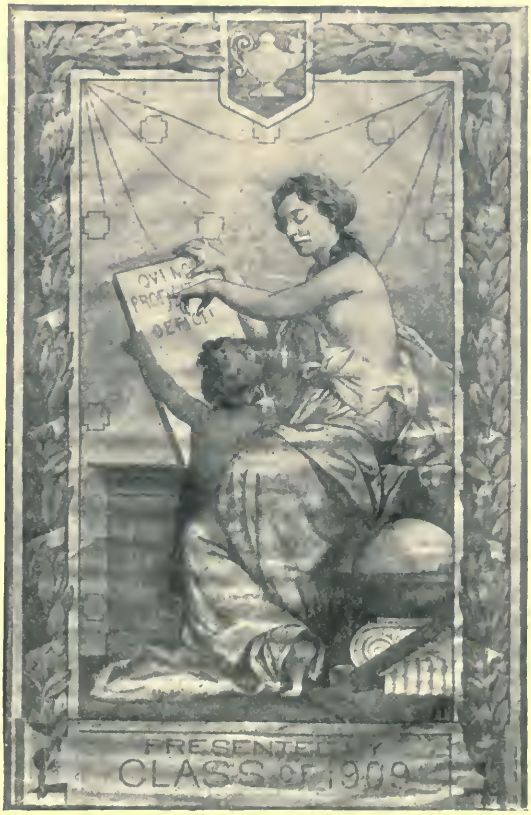
In richness and harmony of colouring modern British work is often considered superior to French work, and if this is so it is due to the genius of William Morris and his helpers, most of whom belonged to a new movement in art distinguished by its splendour of colour and its originality in design. The French work, on the other hand, has tended to grow refined and subtle, so that the bold traditions of the old tapestry-makers have been softened and accommodated to the changing fashions of modern painters. But the French themselves are now aware of this defect, and are aiming at larger and sounder effects. In many countries of Asia the tapestry-makers keep to most ancient schemes of colour, so that some authorities are able to trace in a modern hanging from Persia the traditions handed down from ancient Babylonia. Our oldest European tapestry is connected with the crafts of Constantinople, dating from the days when that city was still a centre of Christian civilisation and the Turks were only a wild clan from Asia. But the Greeks learned their work from Egypt and Babylonia, so that these two countries can claim to be the cradle of the richest and most delicate of all the crafts still left in the world.



A SPLENDID EXAMPLE OF A GREAT HISTORICAL SCENE RECORDED IN TAPESTRY: KING CHARLES V. OF SPAIN REVIEWING HIS ARMY AFTER THE CONQUEST OF TUNIS

TAPESTRY IN AMERICA

In 1893, William Baumgarten introduced the art of tapestry weaving into America. The first loom was set up in New York, with M. Foussadier as manager. Four more weavers soon followed and the infant industry was moved to Williamsbridge in New York City, and located in a building which had formerly been a French hotel in the midst of a French colony. The Frenchmen gladly welcomed the new arrivals from Aubusson. The industry grew until the number of looms increased to thirty-six, each accommodating from two to four weavers.



Courtesy of Wm. Baumgarten & Co., New York.

This modern tapestry, representing Education, was presented to the Normal School of Greeley, Colorado, by the graduating class of 1909. The motto, "Qui non proficit, deficit," means "He who does not advance goes backward."

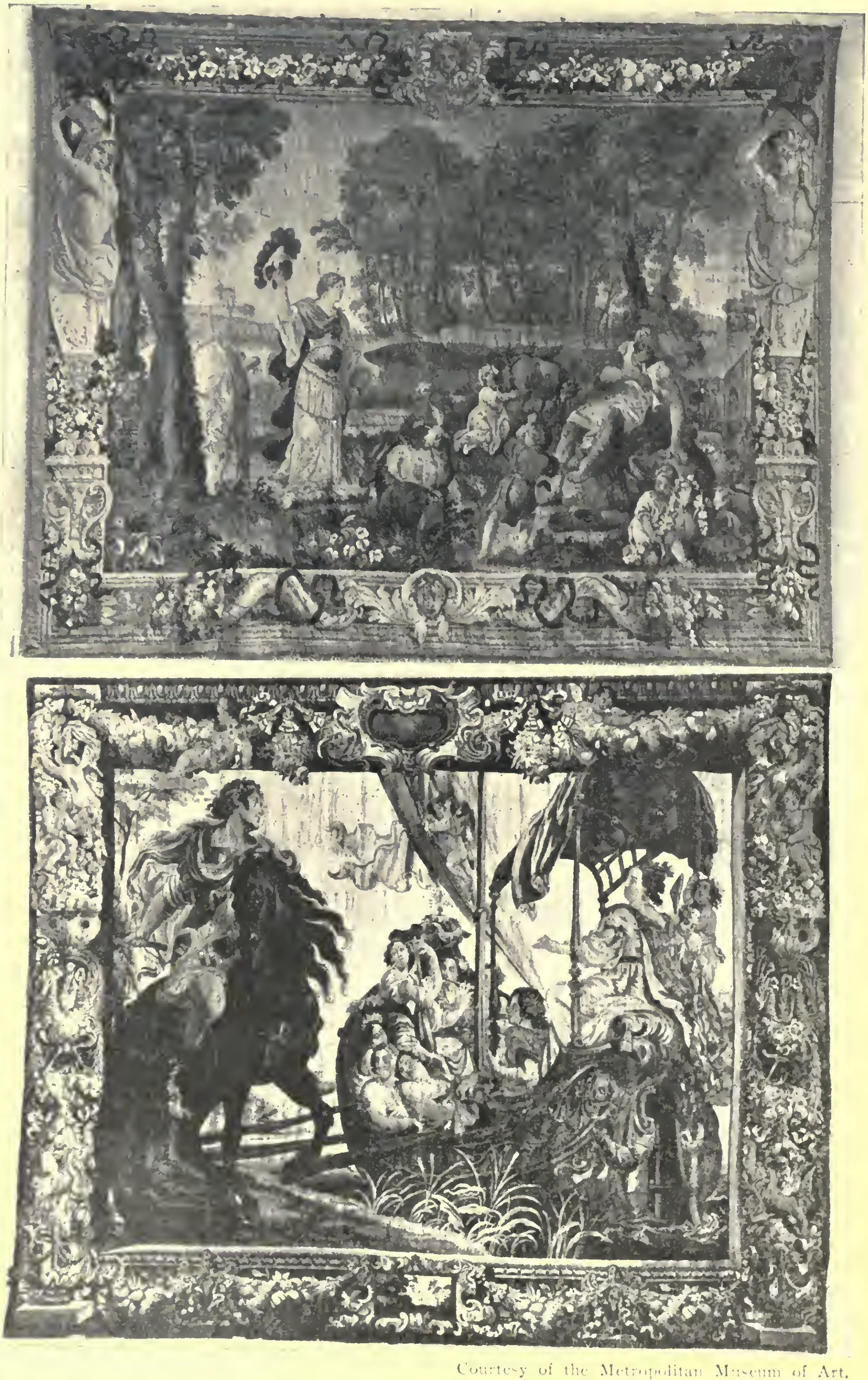
Here tapestries are woven and repaired with skill and taste equal to that of the Gobelins and Beauvais. Here is the largest plant making real tapestries outside of France. It was awarded a Grand Prize at the St. Louis Exposition in 1904 and the French jurors required special evidence to convince them that the Baumgarten panels, to which it was awarded, were American and not French. The tapestry at the Panama-Pacific Exposition in 1915, illustrating Western Immigration, from Leutze's famous painting in the Capitol, Washington, was made at Williamsbridge, New York. While this wonderful piece of work was being woven, many school children in the vicinity went to see it. The artistic handling of the colours and clever weaving have made the impressive scene stand out in a most striking way. "Westward Ho" gives us a vivid picture of a party of western emigrants approaching a gorge, through which they see the desired land in the distance. As the leader halts and directs two men to remove a fallen tree which has impeded the way, he turns to the motley group and points the way to the Eldorado beyond. Young men and old, many of them mounted and bearing rifles, mothers with little children, bright-eyed maidens and frolicsome boys, all seem to be pushing eagerly forward. In the rear mules or oxen pull the covered wagons over the rough way and the cattle follow after.

A family has climbed a pile of rocks and look out eagerly to see the new homeland. One boy, a type of young America, standing erect with his father's long rifle in his hand, is the foremost figure in this group. Two men have climbed a high cliff and are waving aloft the Stars and Stripes. The dark pines form a strong background for these varied groups, but high above them tower snow-capped peaks.

In 1908 Albert Herter established in New York the looms that bear his name. He started to weave tapestries like those woven in the Netherlands in the time of Philip II, Margaret of Austria, and Charles V. Like William Morris, Mr. Herter was a painter by profession, who also had a keen appreciation of tapestry texture and developed it by personal work at the loom. One of the most interesting of the Herter tapestries is a set of panels in the McAlpin Hotel, New York.

In the Metropolitan Museum are many famous foreign tapestries.

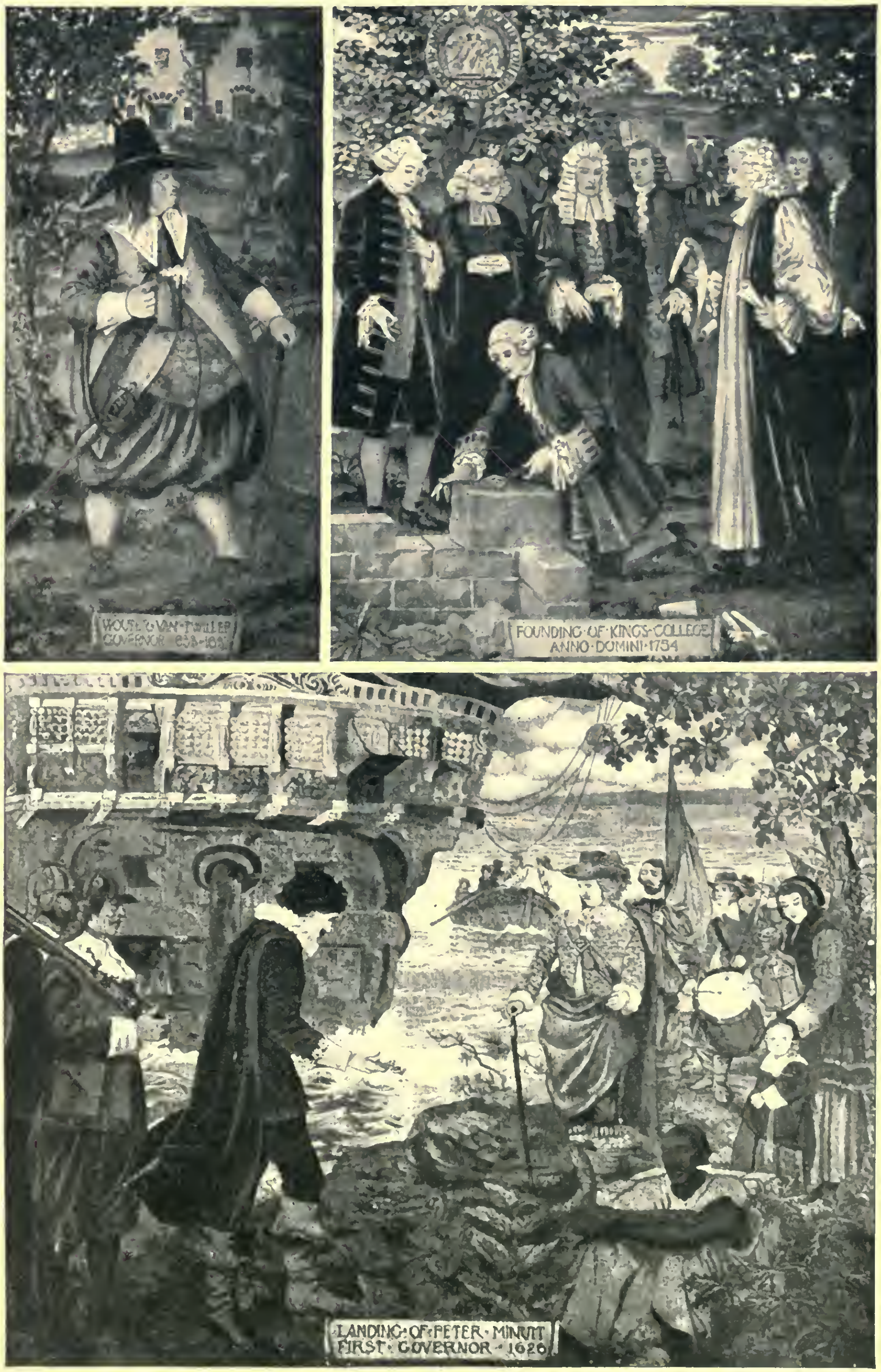
TWO EIGHTEENTH CENTURY TAPESTRIES



Courtesy of the Metropolitan Museum of Art.

The upper picture shows one of a set of tapestries woven in Rome from 1735 to 1739 by Nouzou and Ferloni, which belongs to the Coles collection in the Metropolitan Museum of Art, New York. It represents a scene from Tasso's "Jerusalem Delivered." It was sold for $15,000 in London and brought four times that amount in New York. The lower picture shows a Flemish tapestry woven about the same time, representing "The Meeting of Anthony and Cleopatra."

EXAMPLES OF AMERICAN TAPESTRY



These three tapestries are taken from a set of twenty-six panels, illustrating the early history of New York. These panels were woven at the Herter Looms and are now in the McAlpin Hotel, New York.

THE RIDER HE WILL CARRY HOME NO MORE

THE SILENT SUFFERER OF THE BATTLEFIELD

THE ANIMALS WITH THE ARMIES

THE GREAT PART PLAYED BY MAN'S DUMB FRIENDS IN THE WAR FOR CIVILISATION

THE HORSE THAT HELPED WELLINGTON TO SAVE EUROPE

All the world is different in war; nothing anywhere is quite the same; and it is with animals as with men. The lives of our dumb friends—or of those, at least, which live with man in town and country—are mysteriously changed by the fearful hand of war.

Thousands of horses have been taken from the fields and farms of Europe and America to draw heavy guns or to bear heroes to the field of war; and not only horses, but dogs, mules, camels, and elephants have been helping in the terrible conflict of the European nations. Elephants have been used by the French during the present war, but they were circus elephants, which happened to be performing.

Dogs are largely engaged in Belgium for drawing loads in little light carts, and for hauling to the battlefield machine guns slung on light carriages with wire wheels shod with pneumatic tires. These faithful animals serve, however, in other ways that are most helpful; they help solitary sentinels to keep watch for the coming of a stealthy enemy, and when the fighting is done and the battle has rolled to farther fields, the dogs go out and find the wounded, and call friendly helpers to their aid.

That is what the dogs of war do now. Their work was once more serious. They were then dogs of war in fact as well as in name. In olden time the Belgians used war dogs to attack the Roman soldiery, and from age to age dogs were widely used in war, sometimes for the purpose of keeping watch, sometimes to fight. When one nation found that a rival people derived advantage by setting dogs to attack soldiers, then the breeding of savage dogs was organised, and the possession of four or five thousand dogs was as much a feature of an army as aeroplanes are now. To make them more formidable they were clad in coats armed with sharp prongs and hooks; and sometimes they carried firepots, to set alight the camps into which they were sent. In 1476 the battle of Murten was opened by a fight between thousands of dogs, in which the hounds of Switzerland defeated those of Burgundy. Dogs were used in the Russo-Turkish War less than forty years ago. But now the dog of war is simply a patient helper, not in fighting, but in carrying ammunition and letters, in giving warning of enemies in the dark or in ambush, or, better still, in helping to find the wounded.

The horse has been used in war from the very earliest times, and it still remains indispensable for cavalry and for the movement of guns. The horses of great conquerors have become famous in history; some such horses are more renowned today than men who thought themselves sure of immortality. Alexander the Great had a horse which is immortalised in history Bucephalus. He rode it on his march for the conquest of the world. It carried him for many years, and was thirty years old when it died. Alexander mourned it as a personal friend, and built a city for its tomb. To do honour to their steeds became a foolish passion with later rulers, in imitation of Alexander, and the Roman Emperor Verus caused his battle steed to be fed on almonds and raisins, and stabled, covered with purple, in the imperial palace. The infamous Emperor Caligula stabled his charger in unparalleled magnificence, with a manger of ivory and a pail of gold.

George Washington's horse, a beautiful chestnut with white face and legs, was named Nelson. He rode to victory upon it, and to the independence of the United States. After the last shot of the war had been fired he would never let the horse be ridden again, but turned it out in a paddock at Mount Vernon. Napoleon and Wellington both had famous chargers, and it is startling to think that the fate of Europe once rested on the efforts and strength of Wellington's horse. Its name was Copenhagen, and Wellington bought it for $2000 in 1813, when it was five years old. This was the horse that Wellington rode in all his big battles afterwards, the horse upon which we see him mounted in the pictures representing him at Waterloo. He rode it at Waterloo from six in the morning till ten at night, and then, when he took it to its stable, and gave it a loving pat, it was so far from exhausted that it playfully lashed out and nearly knocked the Iron Duke over.

THE WAR PIGEON AND ITS CAMERA

But perhaps the very greatest service Copenhagen ever rendered the duke was on the day before Waterloo, the day of the battle of Quatre Bras, and the night that followed.

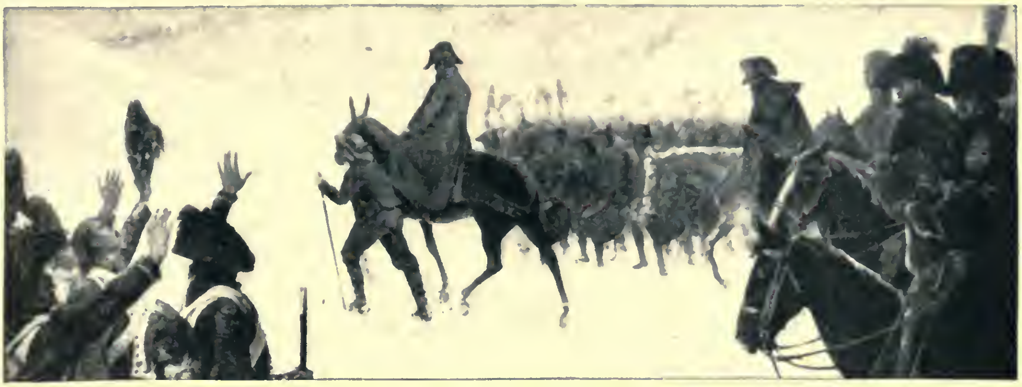
In his early morning movements the duke rode another horse, in order to give Copenhagen a longer rest, but this horse was shot under him, so at ten o'clock in the morning he mounted his favourite. What followed cannot be better told than in the duke's own words. "Before ten a.m. I got on Copenhagen's back," he wrote to a friend. "Neither he nor I was still for many minutes together. I never drew bit, and he never had a morsel in his mouth, till eight p.m., when Fitzroy Somerset came to tell me that dinner was ready in the little neighbouring village of Waterloo. I myself saw the poor beast stabled and fed. I told my groom to give him no hay, but, after a few go-downs of chilled water, as much corn and beans as he had a mind for. Somerset and I ate a hasty meal, and as soon as we had done I sent Somerset off on an errand. This, I confess, I did on purpose, that I might get him out of the way; for I knew that if he had the slightest inkling of what I was going to do he would have done his best to dissuade me from my purpose, and want to accompany me. The fact was, I wanted to see Blücher, in order that I might learn from his own lips at what hour it was probable he would be able with his army to join forces with us next day.

"Therefore, the moment Somerset's back was turned, I ordered Copenhagen to be re-saddled, and told my man to get his own horse and accompany me to Wavre, where I had reason to believe Blücher was encamped. Now, Wavre being twelve miles from Waterloo, I was not a little disgusted, on getting there, to find the old fellow's tent was two miles still farther off. However, I rode on, saw him, got the information I wanted from him, and made the best of my way homewards. Bad, however, was the best; for it was so dark that I fell into a deepish dyke by the roadside, and if it had not been for my orderly's assistance I doubt if ever I should have got out. Thank God, there was no harm done either to man or horse."

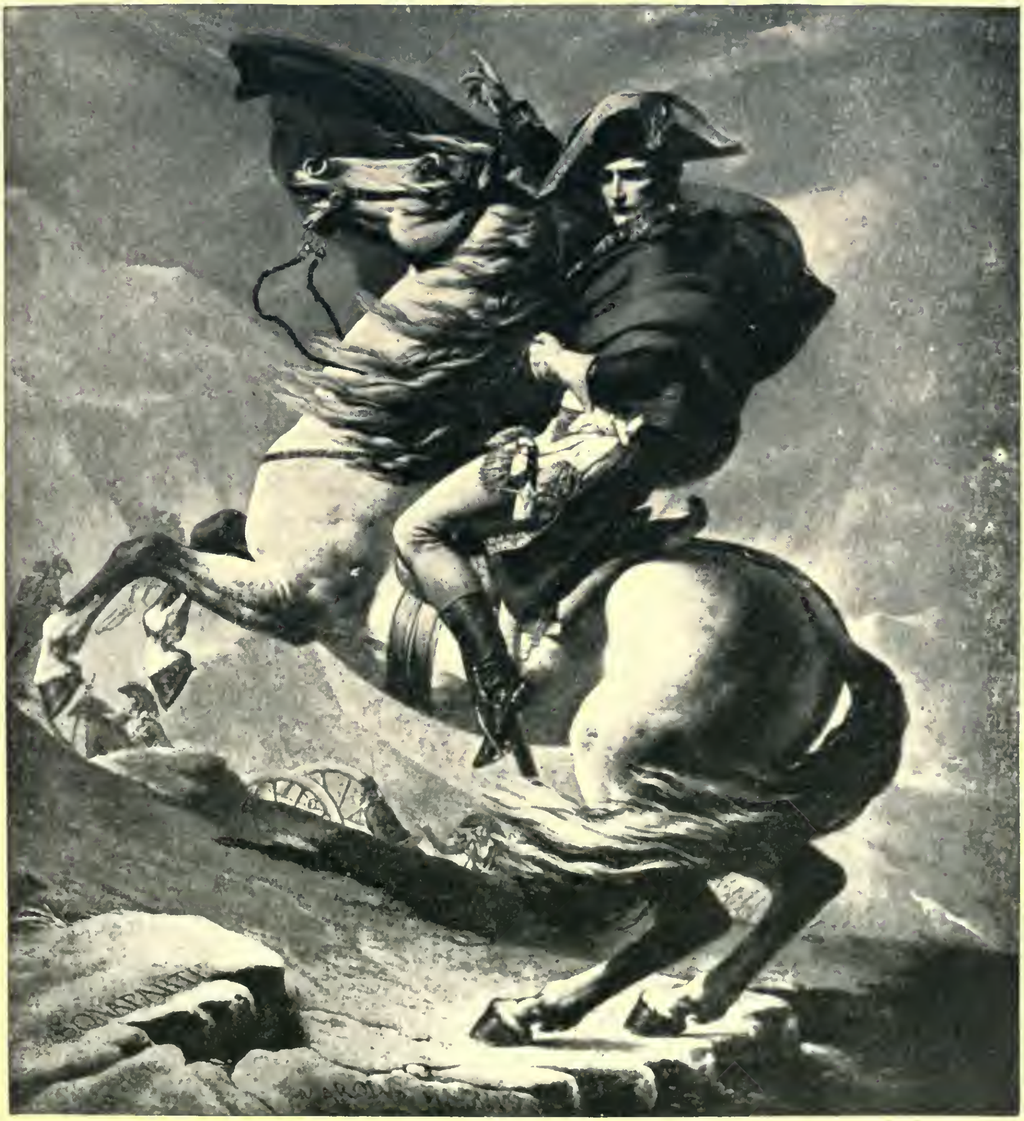
A PHOTOGRAPH TAKEN BY A WAR PIGEON

On reaching his stable, Copenhagen seemed as fresh as ever, though he had borne his master for ten hours during the day, then carried him 28 miles at night. Now, had he failed Wellington, had he broken down on that long night journey, or run away in fright when his master fell, England might not have found salvation at Waterloo on the morrow.

HOW NAPOLEON WISHED TO BE REMEMBERED



HOW NAPOLEON ACTUALLY CROSSED THE ALPS—COMFORTABLY ON THE BACK OF A MULE



HOW NAPOLEON INSISTED ON BEING PAINTED IN HIS RIDE ACROSS THE ALPS ON MARENGO

Wellington needed a good horse of this kind, for he was a poor rider, and tumbled off with as little excuse as the White Knight Alice met in Wonderland. And, oddly enough, Napoleon was another bad rider. His horses were trained to endure without stirring every kind of surprise and shock; to stand blows such as they might accidentally receive in battle, to listen without flinching to drums beaten, pistols fired, and crackers let off at their ears, heavy things rolled against their legs, and even sheep and pigs driven under them. Who would think the lovely white horse, the famous Marengo Napoleon rode at Moscow and Waterloo, had been through such a drilling as this? Marengo was the horse's first battle, and so Napoleon named him Marengo.

By a strange coincidence, the remains of both Napoleon's and Wellington's horses are in England. After the battle of Waterloo, Marengo, wounded, as he had many a time been, was captured by a captain in the British Army. He was brought to England and cared for till he died, and his skeleton is now in London. One of the hoofs of the animal was made into a snuff-box, which is produced each night after dinner by the officers of the royal guard in St. James's Palace, London. Copenhagen passed many years of leisured happiness in the paddocks of the Duke of Wellington's seat at Strathfieldsaye, and saw his sons and grandsons grow up as handsome and faithful as he.

A CONVOY OF ASSES IN THE DESERTS OF ALGERIA

He long outlived Napoleon, and when he died he had a military funeral. He lies buried in his paddock at Strathfieldsaye, and a stone placed over his grave is inscribed:

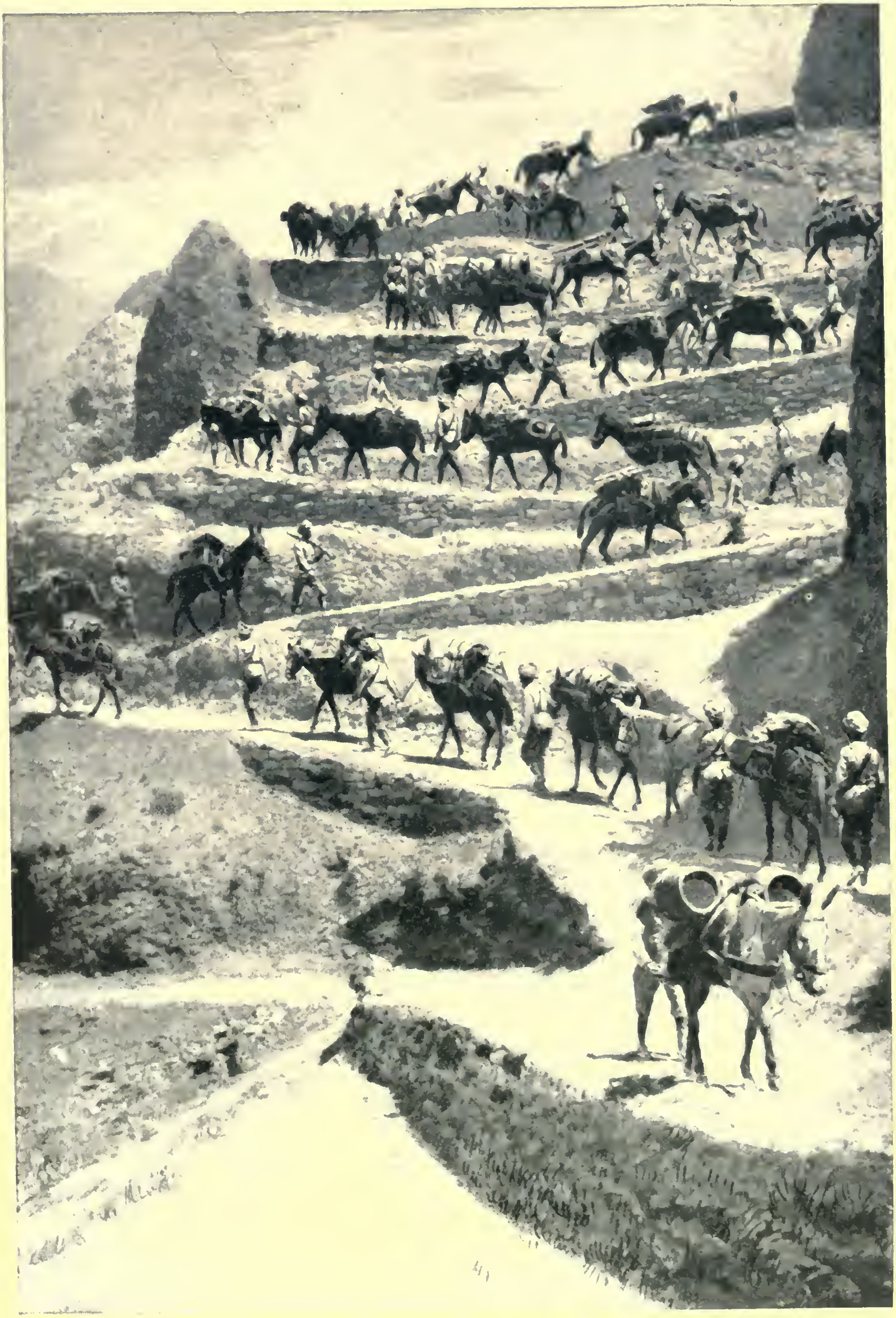
> Here lies Copenhagen, the charger ridden by the Duke of Wellington, the entire day, at the battle of Waterloo. Born, 1808; died, 1836.
> "God's humbler instrument, though meaner clay,
> Should share the glory of that glorious day."

Marengo appears in a famous picture of Napoleon crossing the Alps, but, though the horse made the journey, Napoleon actually rode a mule. When the painter proposed to put a mule in the picture, however, Napoleon insisted that Marengo should appear in its place. Mounting the horse, he caused it to rear. "Paint me thus," he said, and he was so painted, lightly seated upon Marengo's back, with the glorious animal looking as if he would leap Mount St. Bernard in his stride.

Marengo was not the only horse that made history in the French army. There was a magnificent little mare, Lisette, which lives in the annals of horse romance as having brought her master alive out of battle perils by her own exertions, not simply by her speed and leaping powers, but as an actual fighter. Her owner was one of Napoleon's officers, named Marbot, and, thanks to her courage and stamina, he lived to immortalise her in the book of his experiences. At the battle of Eylau, in Eastern Prussia, Napoleon saw one of his fine regiments in peril of destruction, and wanted an order sent to it. Great bodies of Cossacks lay between Napoleon and his regiment, and first one messenger sent out was captured, and then another, until Marbot was ordered to try on his Lisette.

Now, Lisette had a reputation. She had a vixenish temper, and if she took a dislike to anyone she would attack him in an instant. Marbot could do as he liked with her, but unless he was present it took five strong men to saddle her. Once saddled, however, she could fly with Marbot on her unwearying back. Now her supreme hour had come. Marbot was to ride to almost certain death through the Cossacks to the imperilled regiments. Let him tell us in his

A NATIVE BATTERY MARCHES PAST IN INDIA



THE PATIENT MULE ON THE INDIAN FRONTIER

From The London Sphere, through the N. Y. Herald.

own words how Lisette managed it for him. "Lisette flew," he says, "leaping over heaps of dead men and horses and gun-carriages. Thousands of Cossacks were scattered over the plain. None tried to stop me, partly because of my speed, and partly because each one thought that I could not escape those beyond him. Thus I escaped all and reached the regiment. I found it formed in a square, surrounded by dead men." He delivered his message, and received a pathetic answer from the officer in command, saying that he proposed to stay where he was and fight to the last, as it was impossible to cleave a way through the enemy. Would Marbot take back the French Eagle to the Emperor, and prevent it from falling into the enemy's hands? Marbot stooped to receive the Eagle, the troops saluting it for the last time with their dauntless cry of "Vive l'Empereur!"

The Thrilling Ride Through a Storm of Fire Back to the Feet of Napoleon

"But at that moment," says Marbot, "a cannon-ball passed through the peak of my hat, close to my head. I was all but killed by the shock, but did not fall from my horse. I could still see and hear, though my limbs were so paralysed that I could not move a finger. A column of Russian infantry charged up the hill. I received a bayonet wound in the arm. A Russian bayonet touched Lisette on the hind quarters. The mare rushed on the Russian, seized him with her teeth, and bit him terribly. Then, rushing into the midst of the combatants, she threw herself against everyone she met. A Russian officer laid hold of her bridle. She seized him, lifted him, and carried him to the bottom of the hill, where she trampled on him, then galloped at full speed for the French lines. Thanks to the hussar saddle, I maintained my seat. When near our lines, I found myself in front of the Old Guard. Unable to see on account of the falling snow, they took me for an enemy leading a charge. The battalion fired on me. My cloak and saddle were riddled, but I was not wounded, nor was my mare, which charged the battalion and passed through the ranks." Lisette was back again.

Horses that have become accustomed to the crashing thunder of the guns, the wild blare of the bugles, seem fascinated by the excitement, as hunting horses are excited in their paddocks by the sound of the huntsman's horn and the baying of the hounds. One such gallant animal survived its master, an officer in India, and the soldiers of the regiment subscribed and bought it, for love of the man who, seated in its saddle, had led them through many a desperate fight. When their time came to leave for England, they made over the horse to a gentleman who promised it a home for the rest of its days. But one day, hearing the bugles sounding the charge at manœuvres, the old horse summoned up all its strength, cleared the fence of its paddock with a magnificent leap, galloped with arched neck and erected ears on to the old military parade ground, and fell dead before the troops.

The Strange Scene on a Summer's Night After the Battle of Sedan

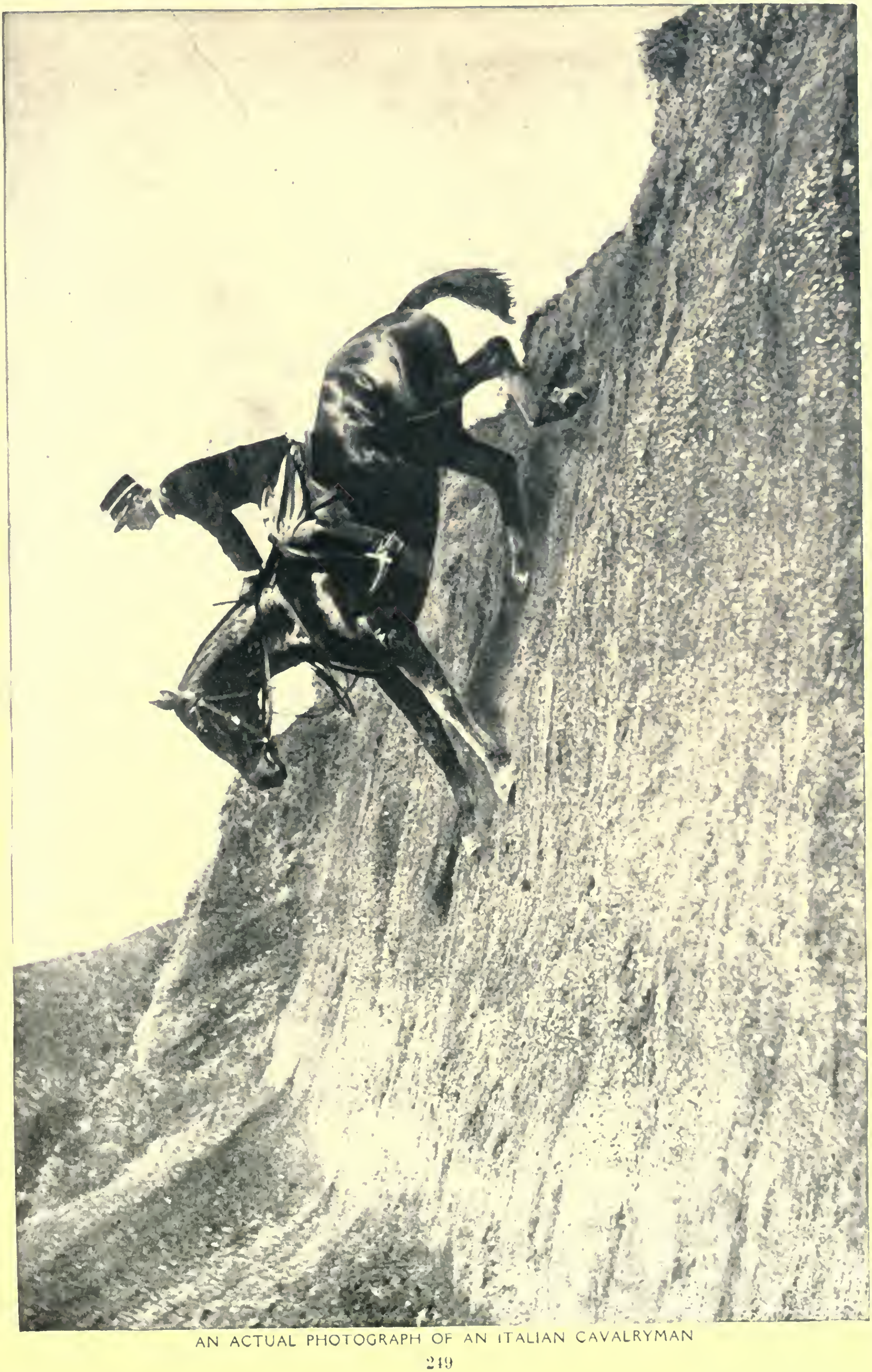
But war is not always attended by issues so peaceful as these; there is that sadder side which the horses share, when the frightened steeds are left to wander riderless from the field on which their masters lie. One of the strangest pictures of this kind has been handed down to us by a gentleman still living, who visited the fields around Sedan a day or two after the battle there.

It was a summer's night, a night merging into morning, and the watcher stood sad and silent, looking across the stricken field where the sun was rising behind a distant forest. And presently, out of the silence, came a strange sound, which became defined as the rapid thunder of the hoofs of fast-galloping horses. Yes, it was horses. Soon they loomed in sight from the forest, fifty or more, riderless, wearing their bridles and saddles. They came on, two deep, in perfect order, as if the gallant French cavalrymen were still in the saddle; on they came, with wide-staring eyes and nostrils quivering and distended. Straight for the lonely man they galloped until within thirty yards of him, when the double line halted dead as at the word of a command.

Was it the Sight of a Man that Brought the Riderless Horses from the Forest?

How had they come together, and what instinct made them gallop in such perfect order? And what had brought them there? Surely it must have been the sight of a man, the sense of friendship, the sense of loneliness and craving for his company, that had made them gallop from the deep shadows of the forest as if to await command. He spoke to them soothingly, and they watched with eager attention, but when he advanced one horse was seized with fear, and in an instant the fear of the one communicated itself to them all. They wheeled to the left as if on parade, and fled back to

THE AMAZING THING A WAR HORSE CAN DO



AN ACTUAL PHOTOGRAPH OF AN ITALIAN CAVALRYMAN the forest, still in their double line, like swift phantoms of the night.

Not only the animals they need, but animals they love, often accompany our soldiers to battle. British soldiers are generally big, brave, but tender-hearted fellows, and there is hardly a regiment that has not some sort of pet—a bear, a goat, a gnu, or a dog, or a cat, or a monkey. In the Crimean War the gallant Grenadiers left their pets at home, but in marching across country to battle they picked up another—a cat. And during one of the fiercest engagements, the battle of the Alma, the colonel, as his men were about to charge, asked, "Where's our cat, boys?" A soldier answered with a roar, "Here she is, sir!" and, opening his knapsack, exhibited pussy, safe and sound, fat as a mole, but a little offended at being roused from a comfortable snooze, even though a historic battle was raging. There was at least one pet dog on the battlefields of Manchuria, a pretty little Pekingese, and a gallant young Japanese lieutenant picked it up. Presently the Japanese had to charge, so the lieutenant popped his little friend under his arm, and, racing, sword in hand, at the head of his men, captured a Russian trench, with neither the dog nor himself the worse for the adventure.

Of course, the fighting heroes are not really supposed to have their pets with them in battle, but they do, and after the cat which won fame at the battle of the Alma comes another. The family tradition for impudent indifference was valiantly carried on at the stirring sea-fight in the Heligoland Bight during the present war. On one of the English fighting vessels was a lordly little black kitten, which, when the battle broke, was fast asleep under a big gun on deck. When the first shot was fired, the kitten started up in a rage, "spat" indignantly, and used the angry cat language which we all declare to be swearing. But after a shot or two the little autocrat seemed to think that it might as well give up its nap amiably, and watch the fun which its good-natured but noisy human playmates were having. With a critical eye it watched the performance of the crew, never budging from its place throughout the roaring battle; and when the fighting had ended it settled down as if tolerably satisfied with the way matters had gone.

A CAMEL CORPS IN THE INDIAN ARMY

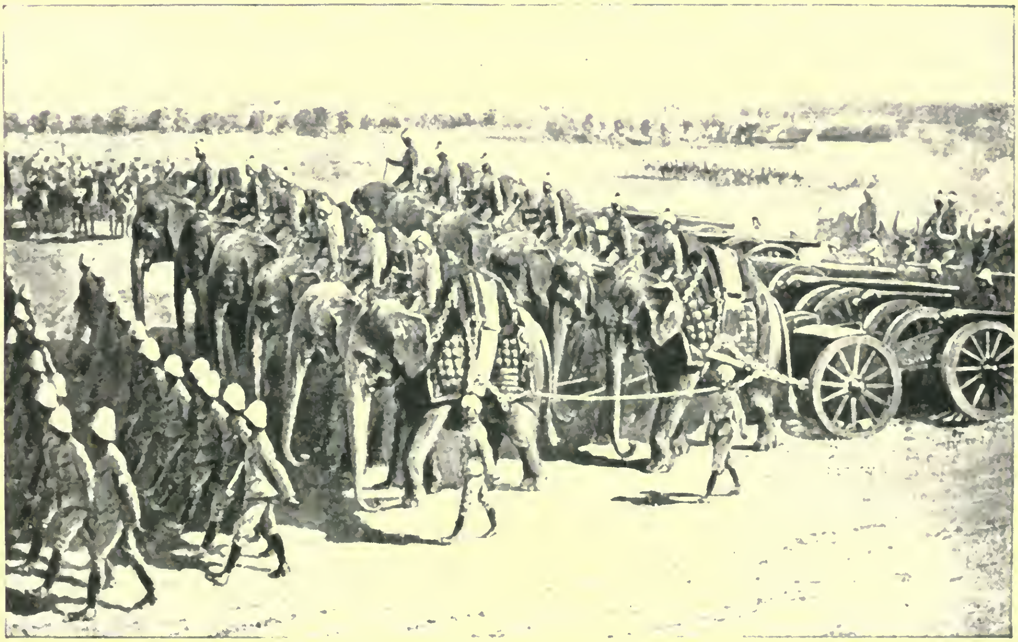
In days not long gone by, when submarines were new to the Navy and the means for keeping the air pure were far from perfect, the crews of these craft all carried white mice or canaries, sometimes both. The little creatures were not there

HOW THE ELEPHANTS GO TO WAR

© Underwood & Underwood

COMMISSARIAT ELEPHANTS OF THE INDIAN ARMY

BRINGING UP THE GUNS


AN ELEPHANT BATTERY IN THE INDIAN ARMY

as pets, however, but as safety gauges. Mice and small birds are more rapidly affected than human beings by impure air. Miners have long used them to detect the presence of dangerous gases in coal-pits, and the men in the submarines were simply taking a leaf out of the miners' book. They took mice and canaries in their little ship under water, and when these quick detectors showed signs of discomfort they knew that the air was becoming foul, and that it was time to rise and take in fresh supplies.

The Pigeon that Flies Over the Battlefield and Takes a Photograph

Happily, the control of air supplies in submarines is now so admirable that the services of these humble life-preservers are no longer required; but we must never forget the part they played in giving safety to the submarines when they were passing through the critical stages of their development. We do not need reminders of such aid to make us fond of our birds and pets, but in the European War, when the people of many towns were left homeless, many incidents occurred which brought out evidence of this abiding affection. An Englishman in Louvain triumphantly saved a canary from the perils of a blazing house, and another brought away his favourite dog and her puppies and carried them across Belgium with dauntless devotion. Another pet has deserved equally as well as the canaries of its owners, and that is the homing pigeon, of which the clever Belgians have made excellent use.

Men, acting as scouts, carry pigeons in baskets on their horses or cycles, survey the country, trace the enemy, write a message on a slip of thin paper, tie this to the leg of a pigeon, and then toss up the bird. The pigeon flies back to its loft, where it is at once captured and relieved of its message, thus giving the military at headquarters valuable information of the movements of the enemy. Pigeons have even been sent up with tiny cameras attached to work automatically, and have brought down actual photographs of the field of war.

The Mule that Turned Round with a Live Gun on Its Back

The humble mule does an enormous amount of good military work in the hilly lands of India. Many mules were employed in the American Civil War, and one nearly brought disaster to a future President of the United States.

An inventor was displaying before General Grant a gun which, he said, could be fired, without unloading, from the back of a mule. The piece was loaded and aimed at a distant target, and the fuse was carefully lighted, while Grant and his officers discreetly placed themselves in the rear. The fuse, however, did not at once ignite the charge, and the mule, hearing the sputtering, turned slowly round until the muzzle of the gun pointed fairly at the general and his staff. Fearfully they all threw themselves on the ground in the nick of time. The gun was fired, and the charge passed harmlessly over their heads, whereat the mule kicked up his heels in disdain, nevermore to be entrusted with a live mountain gun upon his back.

So far we have thought only of animals directly concerned with war, but war affects animals far from the field of battle. The war in Europe is reacting in strange ways upon the wild life of many countries. To some it brings utter disaster, as where fire and famine strike the land; to others it brings prosperity and happiness, as when the harvest fields are left unreaped. In such a case, rabbits, hares, mice, voles, and grain-eating birds have plenty, and multiply, and with their increase comes a corresponding increase of the animals and birds that prey upon them. Where fire and famine strip the land, however, only disaster comes upon wild life. Animals that live on herbs are driven far by starvation, perhaps to die in hosts.

How War Nearly Blotted Out a Race of Deer from the Earth

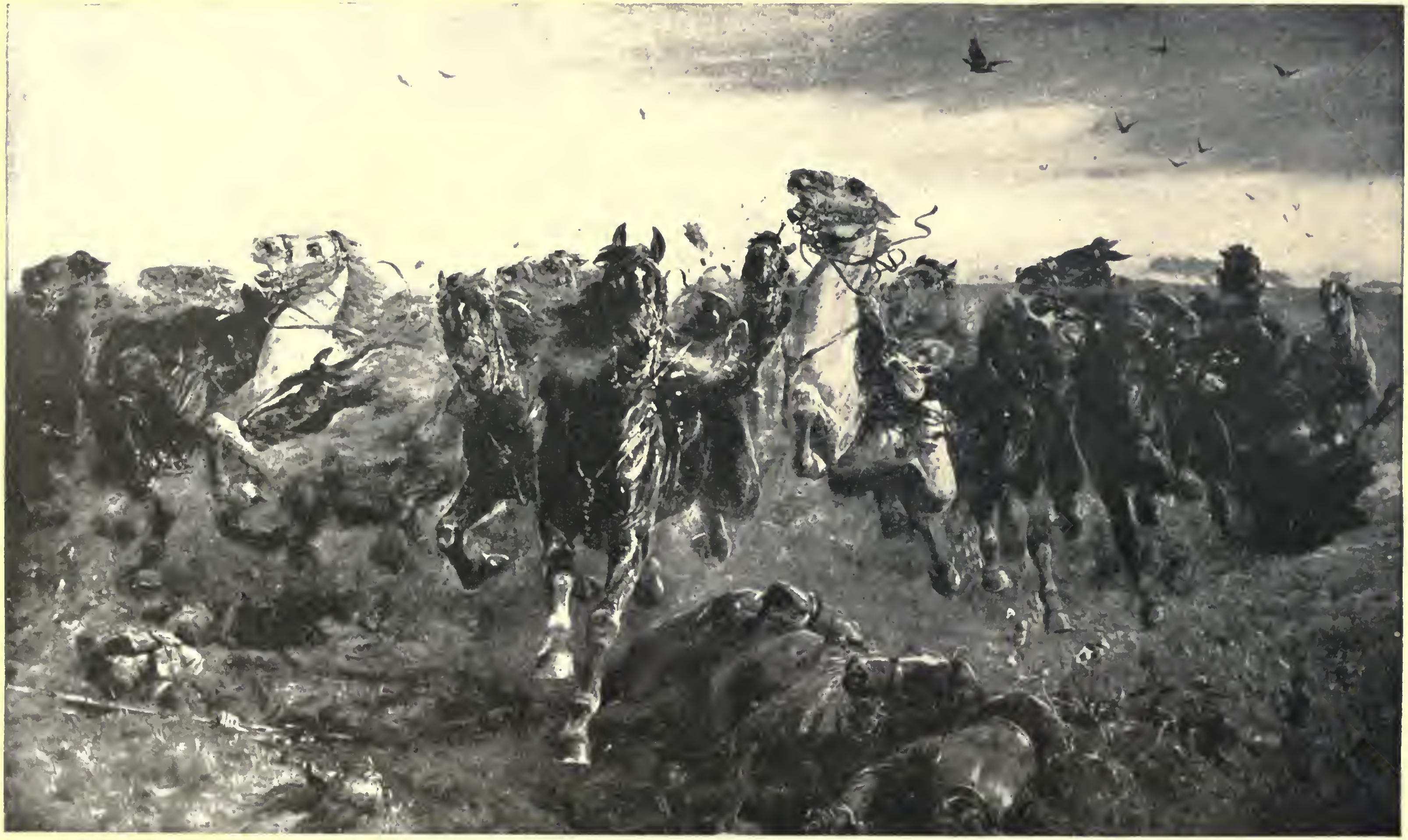
But war acts towards animal life in even stranger ways than this. Take the case of the remarkable Père David's deer, of which the Duke of Bedford, unless he has given any away, has the last in the world. There was a herd of these deer in the Imperial Hunting Park near Pekin. There they were in this park, a Chinese puzzle, derived from we know not where, without close relations anywhere in the world, and therefore very precious. In the year 1900 there was war in China, the war we know as the Boxer Rising. The people were too busy fighting to look after deer at pasture, and the mob swarmed into the park and killed and ate all the deer they could find. The last of Père David's deer disappeared down the throats of the hungry Chinese rebels. Nothing could replace them. China had lost her greatest treasure in natural history. But, happily, the Duke of Bedford had already possessed himself of one or two living specimens from the Chinese herd, and they were safe from the

Boxers in the beautiful grounds of Woburn Abbey, in Bedfordshire. But for that happy accident war would have blotted out from life's volume one of the most interesting living chapters connecting our own age with the times of perhaps millions of years ago, when deer and sheep and goats and cattle were slowly evolving from one common stock to take the forms in which we know them today.

In times of war animals left untended by their masters are thrown back upon such conditions as prevailed when civilisation had not yet dawned, when man had not gone out into the wilds and conquered the humbler creatures; and at such times great changes come over the wild and domestic animal life of a country. Dogs left to themselves in time forget to bark; sheep and cattle become shy and wild. The wars which used to ravage India have left cities unpopulated, and hyenas and tigers and deadly serpents make their homes where once kings ruled. The Roman Maremma, the deadly stretch of land which runs like a green desert of death up to the very walls of Rome, is the result of the wars of centuries ago. Where there were once smiling fertile fields, all is silent now for miles around, the picture of gloom and sickening despair. The undrained land, marshy and pestilent, is the home of malaria so malignant that in the summer-time at a great monastery beyond the walls of Rome, looking down upon the road along which St. Paul walked to his death, the monks have to flee to escape the pestilence that slays by day and night. For two thousand years the scars of war have lain upon that land, and today there is scarcely a sign of life on all its wild horizon. Its character has changed, its life has changed, and no one dares to stay long enough amid the pestilent waste to ascertain what forms of life may have taken the place of the lowing herds which roamed these wide ways when Britain was a Roman province. The wars that shut up Christianity and civilisation in Constantinople made vast tracts of the rest of Europe a wilderness, so that wild boars, wolves, and bears roamed where art and science, learning and culture, had once reigned. The two great countries of the American continent have lived side by side in peace for one hundred years, through settling all disputes by arbitration, which proves that nations can grow without bringing death and desolation to each other.

TWO PICTURESQUE MEMBERS OF THE INDIAN ARMY WHICH IS HELPING IN THE EUROPEAN WAR

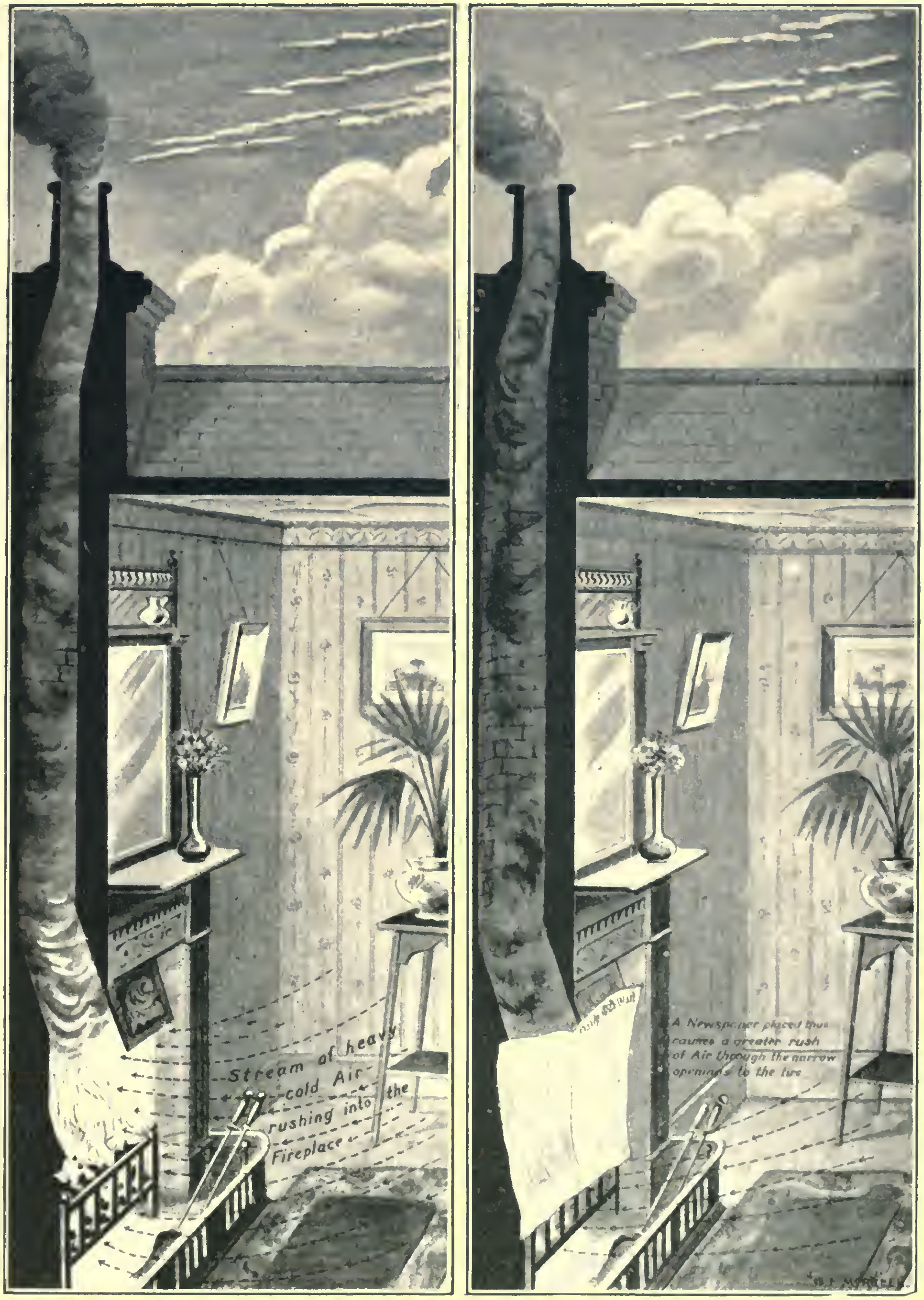
THE WILD FLIGHT OF THE HORSES FROM THE BATTLEFIELD OF SEDAN



THE INNOCENT VICTIMS OF WAR - THIS FINE PICTURE, CALLED "AFTER SEDAN," IS PAINTED BY MR. JOHN CHARLTON, THE FAMOUS WAR ARTIST

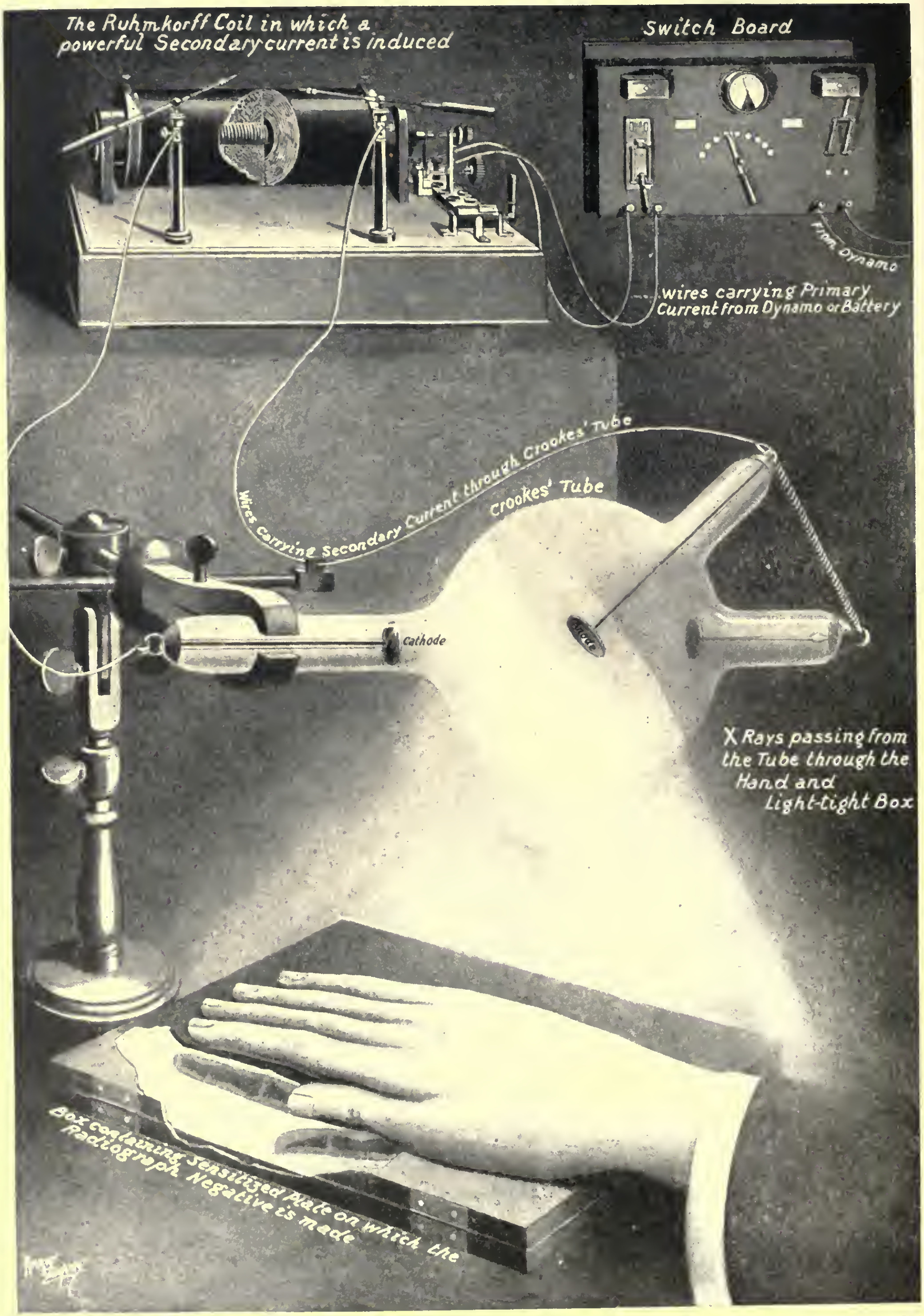
It is reproduced by courtesy of Mr. E. Schumacher, in whose possession it now is.

WHY THE SMOKE GOES UP THE CHIMNEY


Stream of heavy cold Air rushing into the Fireplace
A Newspaper placed thus causes a greater rush of Air through the narrow openings to the fire
W. F. MORRELL

When a fire is lighted, the air round about it gets warm, and, being lighter than cold air, rises and carries the smoke up the chimney. The volume of cold air in the room, being greater than that in the chimney, remains cooler, and as the warm air goes up, the colder air rushes into the fireplace from the room, as shown in the first picture. More than half the heat from the fire in an ordinary grate is wasted by going up the chimney. As the warm air rushes up the chimney, colder air comes into the room through the doors and windows. The second picture shows why a fire burns up when a newspaper is held against the grate, with a space left below for the cold air to pass through. In this way all the air passes through the embers and makes them burn more brightly.

THE INVISIBLE EYE THAT SEES INSIDE A BOX


The Ruhmkorff Coil in which a powerful Secondary current is induced
Switch Board
From Dynamo
Wires carrying Primary Current from Dynamo or Battery
Wires carrying Secondary Current through Crookes' Tube
Crookes' Tube
Cathode
Anode
X Rays passing from the Tube through the Hand and Light-tight Box
Box containing Sensitized Plate on which the Radiograph Negative is made

THE WONDERFUL WAY IN WHICH LIGHT IS MADE TO SEE THROUGH DARKNESS AND PHOTOGRAPH THE INSIDE OF THINGS By the invisible Rontgen rays a hand can be photographed in this way on a plate in a dark box

THIS WORLD OF SHADOWS

THE WONDER OF THE HIDDEN THINGS THAT LIE ABOUT US AND THE MARVELLOUS CHANGES THAT ARE COMING

THE GATES OF THE INVISIBLE WORLD THAT ARE SLOWLY OPENING

A thing is happening in the world which is almost beyond men's dreams. Slowly but surely the veil is lifting from the invisible foundations upon which this world rests, and the invisible world, with all its powers and hopes for the future of mankind, is revealing itself to the human mind.

FOR centuries the wise men of the world have been building up the great book of human knowledge, and a wonderful book it is. But most of its pages deal with the things we see, the things that our hands can touch. Now there is being written a second volume of the story of our world, and its pages deal with the things our eyes have never seen, the things our hands have never touched. The visible earth is nearly all explored. Men are exploring now the invisible world that lies about us on every hand.

The progress of their knowledge of electricity and magnetism — the two great invisible forces that influence our lives in a thousand ways—is the most striking piece of exploration of this unseen world. Its value is plain to everybody. It seems only the other day that the lives of hundreds of people on a burning ship in the Atlantic were saved by means that none of them could see or understand. An invisible force, which our five senses cannot detect, carries a cry for help for hundreds of miles over lonely, stormy seas, and hundreds of passengers on some sinking ship are rescued.

The same invisible force is now used in another form for saving life in our hospitals. It is turned into an unseen ray which strikes through the flesh of our bodies and leaves photographs which enable doctors and surgeons to see what is going on inside us and discern what can be done to cure us if we are ill. The X-ray and the wireless telegraph are both forms of the same unseen energy, which science calls electro-magnetism. And this force is employed in other ways to help us and work for us. It runs our trams and many of our trains, it drives our machines, it makes chemicals for us, it helps to send our motor-cars along, it helps to propel our aeroplanes quicker than a bird can fly.

We are, in fact, living in the age of electricity—the most wonderful of the new forces of the invisible world. But modern men of science know other new things besides this unseen form of energy. They have found out that man is almost blind, and that he cannot even see many objects in the broad sunlight. For they have taken the sunlight and broken it up by passing it through a prism of glass, which spreads it out into a rainbow band of colour.

Our eyes can see only a little ribbon of colours with long bands of darkness stretching away at either end. Both these long, dark parts of the band are composed of real sunlight: one is a part that acts on a photographic plate, the other is the part that acts on an instrument for measuring heat. But our eyes can see neither of these parts of ordinary sunshine, because our optic nerve works in a very limited way and does not use this part of light. We are surrounded by invisible forces—strange, glorious colours that we cannot see, delicate perfumes that we cannot smell, sounds that we cannot hear, and powerful things that our sense of touch cannot feel. Yet the things in this invisible world are of more practical importance to us than the things we see.

The visible world is a land of myths and legends and phantoms. If it were the whole reality we could not live in it. The earth would be a desert, emptied of all forms of life, or, rather, the earth would not exist, it would be blown into bits of rock whirling in wild and scattered ruin around the sun. Unseen forms of life work in the soil beneath our feet and make it fertile. If these invisible things did not exist, not a tree or a blade of grass would grow; there would be no food for any animals, and nothing for us to eat.

The real world of power and infinite life around us is an invisible world. Before we become the lords of the earth we must be awake and alive to the miracles that our eyes cannot perceive.

> To see the world in a grain of sand,
>   And a heaven in a wild flower;
> Hold infinity in the palm of your hand,
>   And eternity in an hour,

was the dream of an English poet a hundred years ago—a poet who was looked upon as a madman. But the dreams of William Blake have now become the realities of the man of science. He does not want a grain of sand in which to see the world. He can divide that grain into more than a million parts, and in one of these parts he can find a universe as complicated as our solar system.

THE MEN WHO STAND ON THE EDGE OF A NEW WORLD OF INVISIBLE FORCES

At present our wisest men are only standing on the edge, as it were, of the new world of invisible forces. They grope, they guess, they fumble, but they cannot tell us much about it. Some of the greatest discoveries are happy accidents—things men hit upon by mistake when seeking something else. A scientist in these days feels something like a child in a fairy tale, wandering through an enchanted forest. Somewhere in the depths of the forest is the great treasure of invisible power. If it is found it will abolish poverty from the world. But the seekers after this wonderful treasure never boast even to themselves that they will find it. They do not even go so far as to proclaim that some man, some day, before life perishes from our planet, will find the great secret power. All they do is to work on in hope, amazed at their own ignorance of invisible things, yet joyful at the unknown fields of adventure that stretch before them.

HOW MANKIND IS RECOVERING ITS SENSE OF WONDER AND AWE

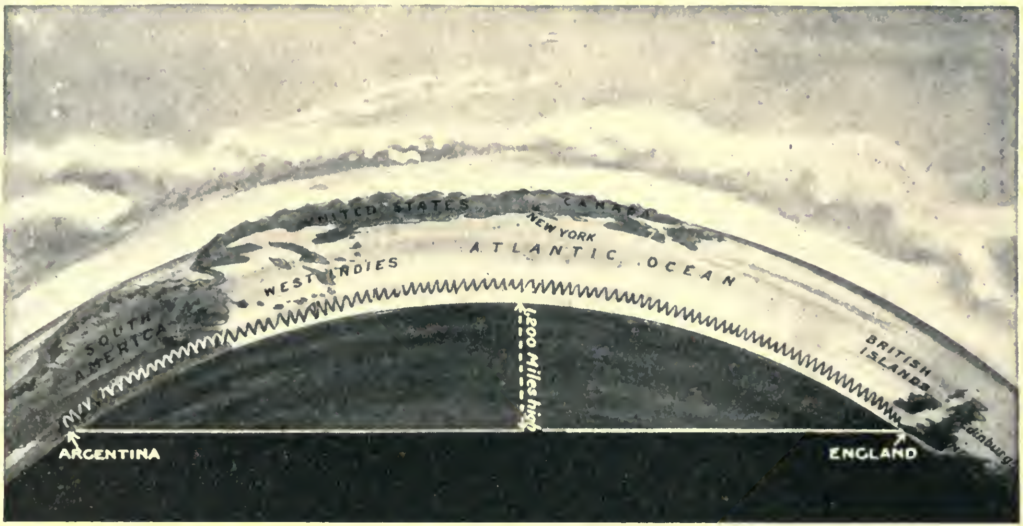
There are two kinds of ignorance. There is the unconscious ignorance of those who do not know they are ignorant, and there is the conscious ignorance of those who know that their knowledge is scanty. A hundred years ago mankind did not know that it did not know; but now the wisest men are humbled in mind and aware of our lack of knowledge of everything around us. We are recovering our sense of wonder, awe, and mystery, for we feel that there are more things in heaven and earth than we have dreamed of. Conscious ignorance of this kind is in itself a stimulus to discovery. It was only when mankind became aware that it knew nothing about the North Pole or the South Pole that daring adventurers began to explore the unknown regions of the earth. So it is with the exploration of the invisible worlds of power and life in which we live and move. They were so near us, and yet so intangible, that we never thought they existed.

Had it not been for Professor Huxley and the head of the Royal Society, the invisible force behind the wireless telegraph might have been discovered and put to use in 1879. In that year an Englishman, Professor Hughes, was making experiments with a telephone instrument. He put up a machine that produced electric sparks, and as he listened, hundreds of yards away, it seemed as if something happened every time the machine gave out a spark. He made other experiments, and came to the conclusion that he had found a new kind of invisible light. It was already known that light consisted of ripples of electro-magnetic energy, which spread from a flaming substance, in the same way that ripples spread from a stone thrown into a still pond. But nobody would believe that there were such things as electro-magnetic waves which rippled along like rays of light but remained invisible, because they were too long or too short to affect the nerves of our eyes.

THE WISE MEN OF OTHER DAYS WHO DID NOT BELIEVE IN WIRELESS WAVES

Professor Hughes found that his telephone instrument was a new kind of eye. It responded to the waves set up by the electric spark hundreds of feet away. By varying his spark, the professor obtained different kinds of waves, and all that remained for him to do was to continue his experiments until he had measured the waves and found whether they could be reflected from one point to another in the way light is reflected by a mirror. This was a long and difficult piece of work, and before entering upon it Professor Hughes submitted his discoveries to Professor Huxley and other famous men of science. They told him that he was mistaken about the nature of his discoveries, and he was so discouraged that he did not publish any account of his work on the great problem. The other men believed only in visible things, and formed a theory about ordinary electric currents by means of which they explained away the strange things that had happened in Professor Hughes's telephone. So wireless telegraphy was kept back.

Nine years afterwards, however, a brilliant young German, Heinrich Hertz, came to the conclusion that electric waves must exist, and that he would find them. He told nobody but a friend what he was doing, and asked for nobody's advice or assistance. He set up a sparking electric machine in his room, and then walked very slowly about holding in his hand a bent piece of brass with two bright knobs. The brass was bent until the two knobs almost touched, and Hertz found that he could pick up little electric sparks between the knobs, even when he was far away from the machine. What happened was this. The big spark set up invisible electric waves, which rippled on until they touched the end of the brass rod, and there they, in turn, produced a tiny spark of electric energy. Hertz measured the waves, and discovered how they could be reflected like waves of light; and when he had worked out the details, so that there could be no doubt about the existence of these strange waves, he published his discoveries. Some years afterwards a French man of science rediscovered the principle of Professor Hughes's more ingenious detector of the unseen electric waves, and this, in turn, was improved by a brilliant boy in Italy, Guglielmo Marconi, who developed it into his system of wireless telegraphy.



THE WONDERFUL WAY IN WHICH AN ETHER WAVE "CLIMBS" ON ITS JOURNEY ACROSS THE WORLD

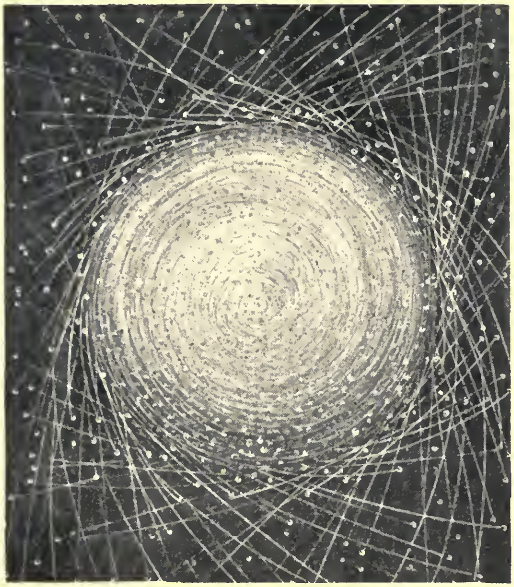
It is not often realised, perhaps, that an ether wave follows the curvature of the earth—that is to say, it rises and falls as suggested here. The picture shows a section of the earth from England to the Argentine, and the "climb" of a wireless telegram on such a journey is shown to be about 1200 miles.

Since then thousands of lives have been saved by the invisible electric waves, and much of the business messages and news reports of the world are flashed for thousands of miles over lands and seas and deserts by means of this new, unseen force. Men can even speak to each other by means of the waves which Professor Huxley would not believe in.

In the last days of September, 1915, the world was startled into wonder by the announcement that a wireless telephone message sent from the station at Arlington, outside Washington, had been distinctly heard at Mare Island, near San Francisco. More wonderful still, the next day it was stated that a message from Arlington had been heard at Pearl Harbour in Hawaii, 4,600 miles away. Less than a month later we were told that a message spoken into a little telephone transmitter at Arlington had been heard at Paris.

Such is the story of the first striking discovery of some of the forces of the invisible world. In 1895 the X-ray was discovered by accident. At that time many men of science were interested in certain experiments with a glass tube. The glass tube was emptied of air and connected with the wires of an electric battery. By this means a discharge of electricity could be sent through the glass tube. The result mainly depended on getting the air out of the tube by means of air-pumps and charcoal, and Sir William Crookes was the first man to produce a really high vacuum in the tube, with the result that he obtained an astonishing effect. Just a little air remained in the glass, and when the electric current jumped from one side of the tube to the other it created a ray out of the rarefied particles of the air. It was a visible ray, and Crookes maintained that it consisted, not of light, nor of electric waves, but of *matter in a radiant state.* Many German men of science then took up the problem with the intention of proving that Crookes was wrong, and that the ray was merely a ray of light.

Professor W. R. Röntgen, of Würzburg, was among these men. He was studying other matters at the same time, and one day his table was in great disorder. There was a vacuum tube placed on a stand and connected by wires to a battery; close beside it was a book the professor was reading, and in its pages was a metal key used as a bookmark. The professor was, among other things, an enthusiastic amateur photographer, and some of his photographic plates were scattered about the table. By one of the happiest chances that ever happened in the world, the book with the key in it was placed on the top of one of these plates.



AN IMAGINARY PICTURE OF AN ATOM WITH RADIUM IN IT, suggesting the energy which is active for centuries, and is now being harnessed for curing disease

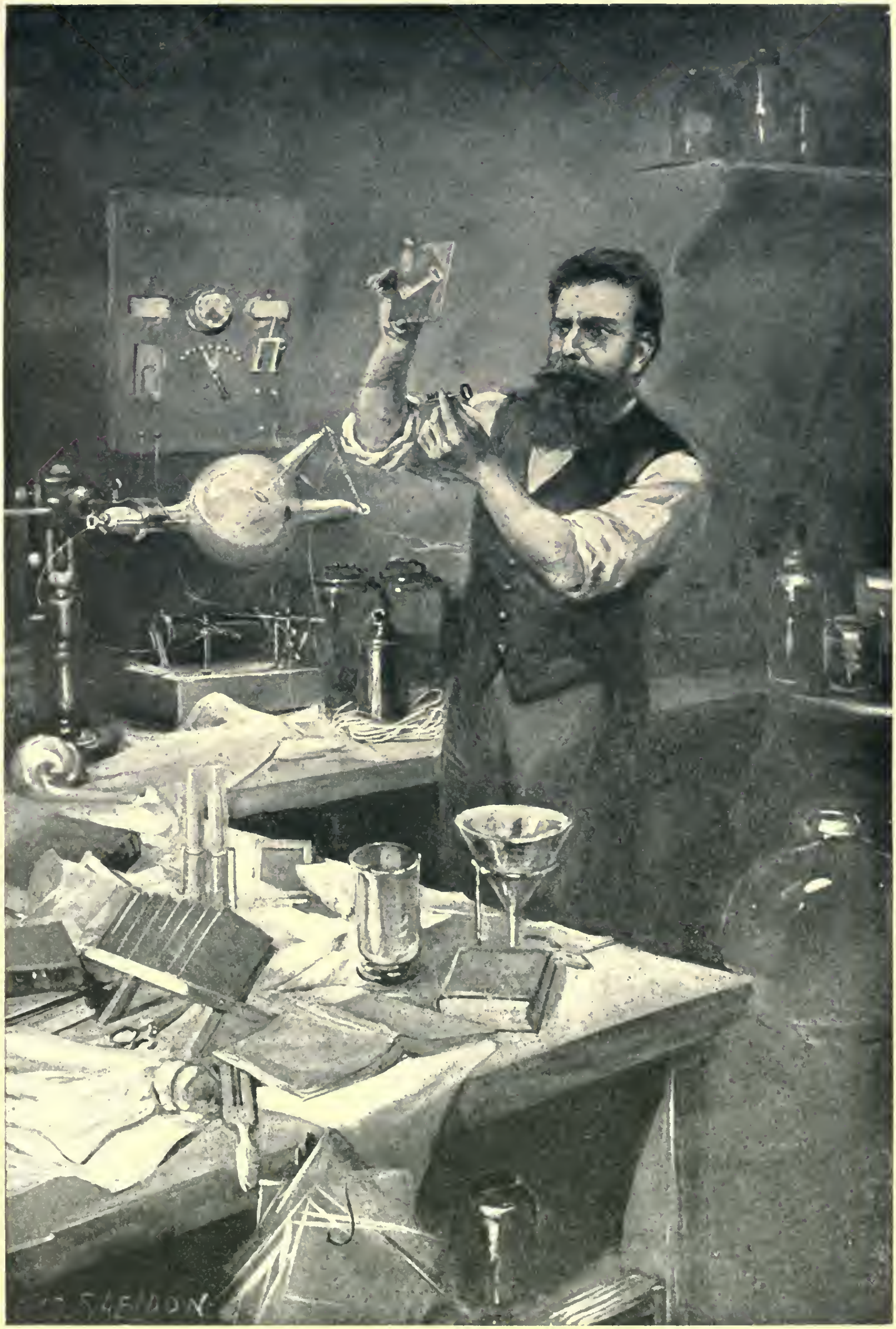
The professor spent some time in sending currents through the glass tube and studying the results, but he could get no new idea from his experiments, and he thought he would clear his mind by going for a walk and taking photographs. He picked up all the plates he could find on his table, including the one that lay beneath the book. Then, seizing his camera, he went out to take photographs. When he developed and fixed his plates, however, he found that one of them was quite spoilt by the shadow of a big key. He recognised the key—it was the one he had put in the book.

So far all was accident, but the professor felt that he was on the edge of a new world of mystery. He began by putting everything back on the table as he had found it before he went out for his walk. He put the key back in his book, and placed the book on another photographic plate near the vaccum tube, and then sent an electrical discharge through the tube as he had done before. Then he developed the plate and fixed it, and found the photograph of the key again revealed. It was now clear to him that he had hit upon an unknown ray which had the power of penetrating a book and affecting a photographic plate.

In great excitement the professor called a few of his best students into the laboratory, told them of his strange discovery, and planned a series of researches. For some time the strange ray remained invisible. Something unseen shot out from the glass tube during an electrical discharge and penetrated thin sheets of metal, thick pieces of wood, and human skin, and left on a photographic plate the clear, dark outlines of metal nails or thick bones, or other things which it could not shine through. Happily, the professor had a curious screen which had been devised for studying certain forms of light. It was coated with certain chemicals which made invisible rays of light—what are called ultra-violet rays — into visible waves of light. When this screen was placed near the vacuum tube, it glowed at each electrical discharge. A student placed his hand between the screen and the tube, and the bones of his hand at once became visible through the flesh! The X-ray was discovered! Another pathway had been made into the invisible world.

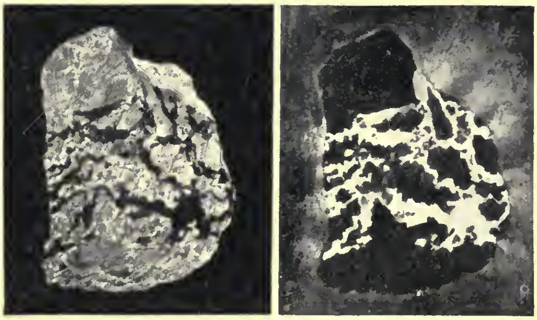
Professor Röntgen spent two years in attempting to develop his discovery, and to ascertain the nature of the new force, and at last published all his researches, giving the strange, unknown ray the name of X-ray, in remembrance of his algebra lessons at school, where x always stood for something unknown. For the last eighteen years men of science in all parts of the world have been labouring with all their might to find out what the X-ray is. One thing they have discovered is that the ray is a power for evil as well as for good. It has greatly relieved various kinds of sufferers, and taken away many of the difficulties of surgeons and physicians, by enabling them to see the bones and some of the principal organs

HOW A NEW POWER DAWNED UPON THE WORLD



PROFESSOR RÖNTGEN DISCOVERING THE MYSTERIOUS PHOTOGRAPH OF A KEY THE FIRST KNOWN WORK OF THE X-RAYS of patients, and it has produced good results in the actual cure of certain maladies. But many of the men who first used it for medical purposes have been attacked by a strange, new disease—the X-ray disease. The operators of X-rays in our hospitals have now to be protected with leaden shields and rubber gloves from this powerful ray, which injures those who work with it regularly, but benefits those who are exposed to it only for a few times in their lives. The man who works all day by an X-ray tube is in extreme danger, and if he continually exposes his hands to the rays he suffers terribly. The new way is to build in a hospital a small room of lead, which the patient enters, while the operator stands outside and works the X-rays by means of a mirror. So the patient benefits and the operator does not suffer.

In spite of all the work done on the new rays, it was long before men discovered what they were made of. Some thought that they were tiny particles of matter in a radiant state; others considered them to be fierce spurts of electric energy. Everybody thought they were something extremely powerful, shooting like a rain of flaming bullets or a stab of lightning through solid matter. The trouble was that no experimenter could find a way of turning them from their path and making them shoot in another direction. We can do this with a beam of visible light by means of a mirror, and men of science can just as easily deflect the invisible trains of electric waves used in wireless telegraphy. But for seventeen years nobody could turn an X-ray from the path it took when it shot from the vacuum tube. It has lately been discovered, however, that if a crystal is placed in the path of the X-ray, and a photographic plate is placed behind the crystal, the photograph will show that the ray has been turned from its course. By using various kinds of crystals, it has been found that the X-ray is of the same nature as visible light and invisible wireless rays. The only difference is that the electric waves in an X-ray are extraordinarily small—somewhat smaller than an atom.



HOW RADIUM WRITES ITS AUTOGRAPH

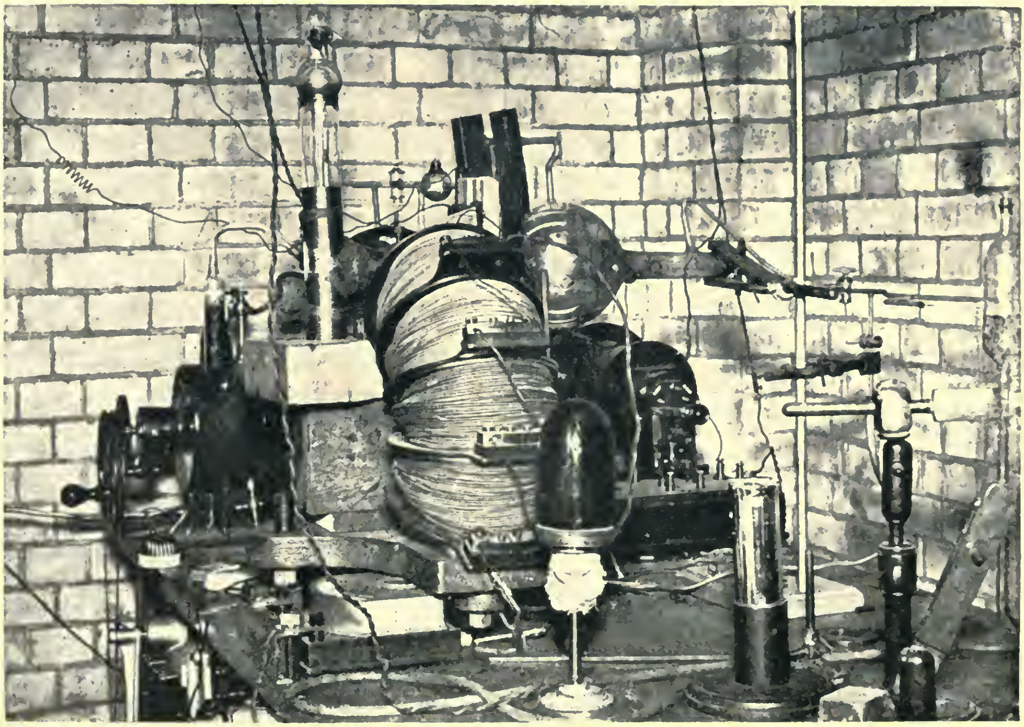
The dark patches of pitchblende in the rock on the left, when placed over a photographic plate in total darkness, were photographed as patches of light, showing that radium rays are emanating from them.

The X-ray, with its dark, invisible light, has become the lantern of the newly discovered world of unseen forces. In some cases it has led men astray, but their wanderings have brought them to still stranger and more unexpected sources of power. For instance, a French man of science, M. Becquerel, thought the X-ray was probably a form of radiant matter, and began to search for other things that shone with an invisible light. He started by using an ordinary photographic plate. Each plate was placed in a box with some metal or substance; the box was carefully sealed and set in a dark cupboard. It was soon found that certain forms of matter emitted an unseen radiance—something that could not be seen with human eyes, but affected the chemicals on a photographic plate, even though a sheet of metal or wood covered the plate. It was also discovered that this dark light was connected with the emission of electrical energy. So an instrument for measuring electricity was used instead of a photographic plate, and a Frenchman and his wife, Professor and Madame Curie, offered to undertake the laborious task of tracing the principal source of the strange light that came from a substance called pitchblende.

This is a dark, metallic substance found in various mines, and usually regarded as a nuisance. The Curies broke it up into its elements, using all sorts of devices to get rid of the stuff that did not make their electrical instrument work. Gradually they obtained a tiny amount of a new substance which showed great electrical power, and at last they were able to announce to the astonished world the discovery of the new and mysterious element of radium. Radium is the key to the great secret of the invisible universe. It contains many sorts of power, each manifested by a different kind of ray. There are X-rays in it twice as strong as the ordinary X-ray; there is another ray which can be collected in a leaden vessel and shown to be, not a form of light, but a form of matter; and there are other rays in radium which are called after various letters of the alphabet. Some of them can be split from the others and turned out of their path by bringing a strong magnet to play upon them. Others rush through the strongest kind of magnetism that man can make, and show not the least swerve as they do so.

The X-ray was a mystery of man's making, and man is slowly mastering this strange new power that he has found. Radium is a mystery of Nature's making, and it may be hundreds or thousands of years before man is able to master it. Perhaps he never will master it. But he lives in hope, and it is the hope of discovering the great secret of the invisible world that now inspires our men of science. They see now that Plato, the wise man of ancient Greece, was right in saying that the world we see is a world of illusions. Plato declared that mankind was living in a dark, narrow, underground cave, into which there entered only a feeble glimmer of light from the real world, so that the things in the real world were known to men only by dim shadows cast on the walls and floor of the cave. If some of the prisoners were to escape to the upper world of light, said Plato, their eyes would be so dazzled that they would not at first be able to see anything real. They would still mistake the shadow cast by a tree for the tree itself. It would take them a long time to see real things as they really are.

One of the first men to escape from the cave of illusion, and so to get a glimpse of the realities of the invisible world, was Sir J. J. Thomson, the famous scientist of Cambridge University. He was experimenting in 1897 with a vacuum tube such as that with which Professor Röntgen had found the X-ray. It was not the new invisible ray that Professor Thomson was studying, but the ordinary visible ray that shines feebly through the glass tube during an electric discharge. He had been studying it for fourteen years without obtaining any result, and when he at last obtained a result he could not believe it. He thought he had made a mistake. He was trying to measure the particles of electrified air that formed the visible ray, and he hoped that they would prove to be atoms, but when he discovered a way of measuring them he found he had got hold of the matter out of which the material universe is built. He had broken the thin air in the tube into atoms by his electric discharges, and had then broken these atoms up into something smaller still. It is extraordinarily difficult—it is almost impossible—to give an idea of the

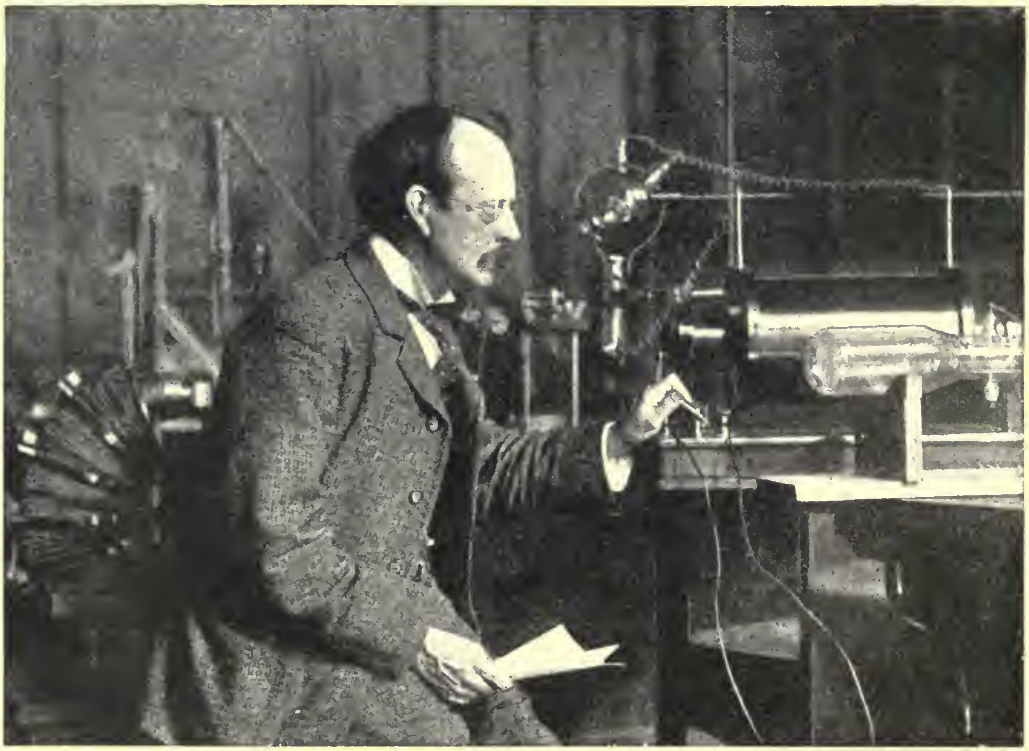


THE REMARKABLE INSTRUMENT AT CAMBRIDGE UNIVERSITY WITH WHICH SIR J. J. THOMSON IS STUDYING THE ATOM AND ITS INVISIBLE PARTS extreme smallness of the things that Sir J. J. Thomson discovered. Let us suppose that a drop of water was magnified to the size of the earth. It would then be possible to distinguish the molecules of which it was composed. The molecule is made up of atoms. Now, suppose, again, that we could magnify the atom to the size of a large room, then the particles which Sir J. J. Thomson discovered would look like specks of dust spinning about inside the room.

It is surely wonderful to think that man, with his five dim senses, is able to penetrate to this extraordinary limit of the invisible world. Our real eye is invisible; it is the intellectual power of the human spirit that discerns these mysteries of the material universe. Our intellect constructs instruments which see and feel and weigh better than we can, and with these new mechanical senses we are beginning to explore the unseen worlds about us. Sir Joseph Thomson's discovery of "electrons," as the thousandth part of an atom is called, has enabled other men to understand a little about radium. It appears that an electron is not an ordinary form of matter, it is merely a centre of electrical force. The material atom is only formed when certain electrons attract each other, in much the same way as a magnet attracts little bits of iron, and so forms a system of forces.

In every atom is a big electron which attracts some small electrons, just as the sun attracts the planets and keeps them whirling around in perfect order.

Matter, indeed, is built up of electromagnetic energy. In an ordinary pebble by the seashore, or a broken flint on a road, there is enough electrical energy to supply New York for hours with electric light and run all the trains in the subway. Unfortunately, however, this wonderful store of electrical power contained in everything material around us is locked up beyond our reach. We cannot break the bonds that hold together the electrons in a pebble and make the energy stream out for our use, in the same way as energy streams out of burning coal. Even in burning coal we do not touch the ultimate supply of power. The heat we set up in a furnace only makes the electrons vibrate, and their vibrations produce electric waves, which we use in the form of light and heat. We never break up the atom of carbon in coal in the same way as Sir Joseph Thomson broke up the atoms of



EXPLORING THE MARVELLOUS INTERIOR OF THE ATOM—PROFESSOR THOMSON AT WORK IN HIS LABORATORY AT CAMBRIDGE air in a vacuum tube. At present it costs more to break up the atom and liberate some of the electrons than it does to get electricity from burning coal, but our men of science hope they will one day be able to discover the key to the great treasure-chamber of power that surrounds us on every side.

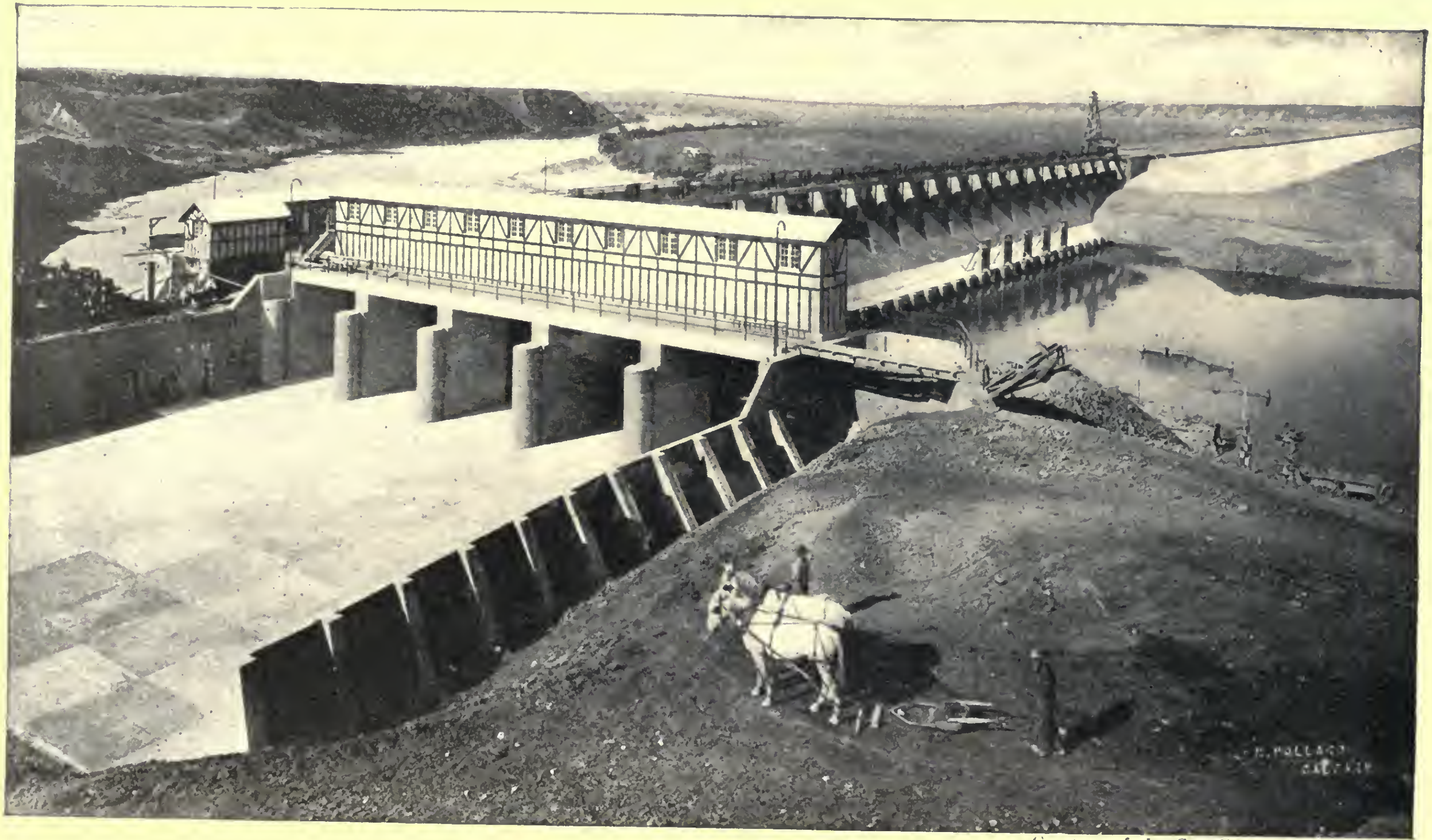
It is radium that is pointing the way to the solution of this great problem. Radium is matter in a radiant state. It burns with terrific force, yet it never goes out. All the radium now used in our hospitals will continue to give out energy for more than a thousand years. If radium were so cheap and plentiful that we could use it instead of coal, our fires would never go out. Our electric generating stations, if kept in repair, would produce electricity for twenty centuries out of a single piece of radium. Our steamships could sail round and round the world without needing fresh fuel. We should need no coaling stations for our battleships. When ships were quite worn out their store of radium would be carried to a new vessel, and the process could be carried on until hundreds of steamers had been built and used up. We could make most of our machinery automatic and insert a piece of radium as driving power, and the machines would go on working day and night. Mankind would be rich beyond the dreams of avarice. The earth would be a playground, for none of us would have to work more than an hour a day. We should grow our crops with electricity, and so increase the supply of food that twice the number of people in the world could live comfortably on our planet.

The trouble is that radium at present is the rarest and dearest of elements. It exists in invisible quantities, and costs $2,500,000 an ounce to collect it. But perhaps in the near future we shall not need radium, for we are already beginning to discover the source of its wonderful energies. It is composed, of course, of atoms, and these atoms are composed of the electrons Sir Joseph Thomson discovered. But the electrons of radium atoms are not stable. Some fly about and produce wild disorder, and then the atoms break down, and bits of them stream out and produce the wonderful radium rays. We could change any bit of matter—a stone, a brick, a piece of wood—into something that would burn with great energy for a thousand years, if only we could set free some of its electrons in the way the electrons of radium set themselves free.

Before we can do this, however, we have to solve the great radium mystery. We have to discover the cause of its radiancy—the thing that loosens some of its electrons and sends them in a fierce bombardment against the other atoms, and that unlocks some of the vast store of electrical energy hidden within it. When this has been found out, mankind may be able one day to set free the electrons in some common form of matter, and thus make it a radiant source of practically everlasting energy. If ever this happens, our coal-mines and oil-wells and wood fires will be unnecessary. We shall have more power than we know what to do with. Working energy for light, heat, chemical operations, and power machinery will be almost as cheap and plentiful as the air we breathe. A quick and easy way of breaking up an atom into the electrical energy of which it is composed will entirely change the fortunes of the human race. Man will then be, indeed, lord of the earth.

And that day will come. Slowly but surely the truth is dawning upon mankind that the invisible forces of the world are the great reality, and that the things our eyes can see are but the dim shadows of the wonderful unseen universe.

THE BASSANO DAM—AT PRESENT THE LONGEST IN AMERICA



Courtesy of the Canadian Pacific Railway.

This dam across the Bow River in Alberta, Canada, consists of two parts. In the middle of the picture you see the reinforced concrete spillway and to the right the earthen embankment. The total length is almost one-and-a-half miles. The dam has raised the water at this point so that it forms an immense reservoir. When more than the required amount flows into this reservoir, it may be let out through the gates of the spillway. On the left you see the headgates of the main canal, through which the water is released to the branch canals, reservoirs, and ditches, which extend more than 4,000 miles. The region is neither desert nor arid but has had occasional dry years. The project has been developed to provide sufficient water at all times. As it comprises 3,000,000 acres, it is at present the largest irrigation project in America.

HOW NATIONS WATER THE LAND

IRRIGATION WORKS, ANCIENT AND MODERN

ATTEMPTS TO SUPPLY THE LACK OF RAINFALL WHEN NEEDED

ONE of the marked differences between a savage and a civilised man is that the one trusts to nature to supply his needs while the other works for what he needs. It was agriculture, the labour of cultivating food plants, that made man civilised. The first of the ancient peoples to emerge into the dawn of history, the first to become great nations, were farmers.

We must not, however, place too much blame on the savage peoples of that period because they did not take to agriculture and so become civilised. They remained savages, not because their natures were necessarily bad, but because the soil in the countries they inhabited was not suited to agriculture. The civilised nations became great because they were fortunate in having settled on lands that were fertile.

CIVILISATION IN EGYPT DEPENDENT UPON WATER

Thus it was that the Egyptians were the first people to become civilised. When their early ancestors settled in the Nile Valley they found the soil along the banks of the river Nile wonderfully fertile. Far up, near its sources, there are some big lakes which act as reservoirs in storing the water and regulating its flow. Because of this the rise and fall of the Nile is almost as regular as clockwork. On almost the same day each year, in the fall, the waters begin to rise and spread slowly over the adjoining fields in vast, placid lakes. Then the flood begins gradually to recede. By June the river is back in its regular bed and the drained off fields along the banks are left with a thick cover of sediment, or mud. This the early Egyptians would plough up with their forked logs and plant wheat and barley. The crops would then grow and ripen without a drop of rain.

On account of these fertile lands producing such rich crops the Egyptians became a very prosperous people. Prosperity gives people leisure; the time in which to think and develop their brains. With such a surplus of food products everybody had more than enough and part of the people were able to devote themselves to other occupations. Some took to studying the forces of nature about them, a system of writing was invented, and learning and civilisation followed.

HOW THE AREA OF FERTILE LAND WAS EXTENDED

With their intelligence once awakened, it was only natural that such a people should seek means to improve conditions about them. Already they had learned to realise that nature is most bountiful to those that assist her. Probably, too, the population was increasing and more food products than could be raised along the banks of the river were needed.

By this time the learned men among them had made certain observations along their great valley. They saw that the river, flowing down the centre, was slightly higher than the level of the desert away from the banks on either side. For ages the Nile water had deposited its sediment along the banks until they had been raised and formed a sort of very wide embankment on each side, not unlike the levees which are built along the Mississippi, to keep the river from overflowing on to the adjacent fields.

Imagination always follows awakened intelligence. The Egyptians, therefore, could readily imagine what would happen if the Nile floods could be extended beyond the embankments; the parched deserts would be watered and more crops could be grown there to provide food for the people.

HOW THE AMOUNT OF THE CROPS WAS INCREASED

What was more natural than that the idea of digging ditches through the higher ground should suggest itself to them? That was exactly what they did and when the next flood came the water poured through the ditches and spread over the deserts beyond. There it remained until the river subsided again, then sank into the ground. Crops were planted and harvested on this newly conquered territory. Thus the Egyptians found a means,

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through a little extra labour, to double the area of their farm lands.

So far as we know now this was the first time that irrigation was put into practice. Painted pictures and sculptures on the old Egyptian monuments tell us that four thousand years ago the people of Egypt had already begun to dig these irrigation canals. From these first crude ditches developed a wonderful and complicated system of canals, regulated by sluice gates and embankments. The lands once so parched they divided into big oblongs, separated from one another by low dikes, each oblong being from two thousand to twenty thousand acres in extent. From the canals the water would pour into the first series of oblongs. When the fields there were thoroughly saturated the sluices in the dikes would be opened and the water would pass into the next series of oblongs until finally, when all the land had been well soaked, what was left of the water would be allowed to run back into the river lower down.

OTHER ENGINEERING WORKS IN EGYPT

No doubt it was the engineering skill developed by these irrigation works which encouraged the Egyptians to undertake more ambitious feats: the tombs of their kings and the pyramids testify to their abilities. Not satisfied with mere canal digging, one king hollowed out a big reservoir for storing the flood waters, that they might be used during the periods of low water. This was Lake Moeris, which was supposed to be at least 2,500 acres in extent.

Though they were perhaps the first, the Egyptians were not the only people of antiquity to practise irrigation. In the valleys of the Tigris and the Euphrates, where Nebuchadnezzar set up his golden image and where to-day lies the Bagdad of the Arabian Nights, may still be seen the dry beds of canals that were even bigger than those of Egypt. Here were dug two of the largest canals of ancient times: the one drawing water from the eastern bank, the other from the western bank, of the Tigris. Each supplied many lesser canals which threaded and watered vast stretches of level plain. The big canal on the eastern side was known as the Narhwan. It was 250 miles in length, its depth was from thirty-six to fifty feet and its average width was four hundred feet. Even our old Erie Canal was a mere ditch compared to this. Engineers estimate to-day that the volume of water which flowed through this big canal must have been ten times that of the Thames, in England.

THE HINDOOS PRACTISED IRRIGATION LONG AGO

The Hindoos, too, were watering their fields artificially long before the beginning of the Christian era. But here entirely different conditions demanded the exercise of their ingenuity. India is not a rainless country, like Egypt and Mesopotamia. On the contrary, it is one of the rainiest countries on the globe. England is considered a very moist country, yet in many parts of India thirty inches more of rain fall than in England. In one province, in Assam, there have been years in which six hundred inches of rain have fallen: fifty feet of water. As twenty inches is considered sufficient for farming without irrigation, we might well suppose that the farmers of Assam had no need to worry.

Yet in spite of all this downpour the crops of India frequently wither before they can be harvested. The trouble is that all this rain falls nearly at one time. Sometimes half the rain for the year comes down within two weeks. In some provinces it is not unusual for two feet to fall within forty-eight hours.

Then, of course, the fields are flooded, but after the torrents have washed off into the rivers there is likely to be no more rain for months and the fields become dry and parched. If these dry periods are more than usually prolonged the crops wither before the harvest and the result is one of those horrible famines for which India has always been so notorious. Before railways were built, by means of which relief could be rushed to the starving people, it was not unusual for half the population of a famine district to die of starvation.

Such were the conditions in the great, fertile valleys of India in ancient times. At uncertain intervals would come the drought years and the people would starve in the midst of their withered crops, though only a few miles away rolled the mighty rivers, which carried water enough to flood the land.

SOME OF THE PRIMITIVE METHODS USED IN INDIA

It was the poor farmers themselves who first thought of irrigating their fields. These first rude attempts resembled nothing so much as helping the water climb stairways until it reached a level from which it could flow over the fields along the banks. Steps or terraces were dug out of the embankment beside the river. At each step or terrace was a contrivance the same in principle as we see employed to draw water from wells in some of our old-fashioned farms: a long pole, see-sawing on the top of an upright pole, with a stone at one end and a bucket suspended from the other. By means of these scoops the water would be raised from the river to one step after another, in each of which was a wide hole, to contain the water. From one hole to the next above the water would be lifted and poured, until the man working the top scoop would empty it into a wooden gutter, from which it would flow down into an irrigation ditch. To this day such methods are employed in those back sections of India not yet reached by the modern canal systems.

THE PERSIAN WHEEL WHICH MAY BE SEEN TO THIS DAY

Another early method was the Persian wheel. This resembles an old-fashioned mill wheel, but where the mill wheel is fitted with paddles the Persian wheel has buckets attached which scoop up the water as the wheel turns, emptying their contents into a wooden flume above. Crude as it is, this method is really very effective and is even used in this country to-day by small farmers. Sometimes the Persian wheel was turned by oxen, but sometimes it was turned by the flow of the river, paddles being attached beside the buckets. Thus the power for lifting a steady stream of water was taken from the river itself and the wheel turned day and night, without labour. Even after the Hindoo engineers had laid out and built the big canal systems, quite as big as and more extensive than those of Egypt, the Persian wheel continued to be used by the native farmers, even until the present day.

Nearly all of the ancient canals fell into neglect and were filled up by silt, or sediment. The country in the valleys of the Tigris and the Euphrates became and is to-day practically a desert. The one exception was Egypt. There the old canals were still used by the Egyptians until recent times. It seems only fitting that what is probably the most gigantic irrigation works of modern times should now be found in Egypt.

MODERN IRRIGATION WORKS IN EGYPT

In 1805 Egypt fell under the rule of Mehemet Ali Pasha, who continued in power for over forty years. He was a keenly intelligent man with ideas up to the time in which he lived, though he was of a very nervous temperament. Having the welfare of his country at heart, he determined to improve the irrigating system so that the fields could be watered all the year round instead of only at flood time. This would make it possible to raise valuable crops of cotton and sugar cane for the European market on the rich soil of the Nile Valley.

The Nile floods rise about twenty-five feet at Cairo. Mehemet Ali's first scheme was to deepen the old canals twenty-five feet so that the water could flow into them when the river was low. But after a great deal of labour had been wasted it was found that the canals clogged up with silt during the hot months, just when the cotton needed most moisture.

The Pasha, not discouraged by his first failure, next determined to raise the level of the Nile at low water. This vast undertaking was entrusted to Mougel Bey, a French engineer, and from his plans resulted that great piece of engineering which became known as the Delta Barrage.

THE FIRST PROJECT FAILED TO STAND

At a certain point in that part of the valley known as the Delta, the Nile splits and forms two branches, the western being called the Rosetta branch and the eastern the Damietta. Mougel Bey's plan was to dam these two branches just below the split, enough to raise the water fourteen feet. Then he meant to dig three canals: one running down the middle, between the two branches and one to each side. The central canal was finally completed and did good service. The western canal was also finished, but the winds continually blew the sands of the desert into it, filling it up.

Year after year it was cleaned, but finally it was abandoned as a failure. The third canal was not dug until after the English assumed control.

First of all a concrete floor, ten feet thick and 112 feet wide, was laid across the two river beds. On this foundation were raised huge, stone piers, spanned overhead by arches, on top of which ran a roadway, or viaduct. Inside the piers, below the arches, heavy gates were fitted, which could be lowered or raised, to regulate the flow of the river. The work was begun in 1843 and lasted twenty years.

In 1863 the gates of the Rosetta branch were raised, but before the waters of the river had risen more than a few feet the flooring sagged and the gates had to be lowered again. Again and again attempts were made to raise the gates, year after year, but finally, four years later, the whole barrage cracked from top to bottom. Then the gates were dropped again for good and the work of Mougel Bey's lifetime was declared a failure.

HASTE THE REASON FOR THE FAILURE

Naturally these failures were the tragedy of Mehemet Ali's life, while Mougel Bey's skill as an engineer was thoroughly discredited. But others were to use their failure as a stepping-stone to a big success. To-day Mougel Bey is held blameless by his profession for the unfortunate result of his great work; the failure of the Delta Barrage is now laid, not to his want of knowledge or skill, but to the nervous temperament of Mehemet Ali.

Against the advice of his engineer Mehemet Ali was continually hurrying the work up. Overcome by his impetuosity, Mougel Bey's workmen laid the concrete foundation in running water. The cement was partly washed away, loosening the rocks and gravel with which it was mixed.

When Egypt was occupied by the British the new government began to consider the necessity of improving the old irrigation system. With this object in view many of the world's greatest engineers were consulted. All agreed that nothing could be done with Mehemet Ali's barrage. So, in 1883, it was proposed to abandon it altogether as an irrigation work and retain it only as a railroad bridge. A scheme was prepared to irrigate the Delta by pumping water from the river.

A COSTLY PUMPING PLANT IS PROPOSED

It was estimated that the pumping plant would cost about three and a half million dollars and the yearly working expense would be a million. But just then there arrived in Egypt an engineer who had been in charge of the canal building in India: Colonel Scott Moncrieff. Into his hands the British government put the business of improving Egypt's irrigation works.

The first thing that Colonel Moncrieff did was to veto the pumping scheme. And, to the horror of all the engineering world, he decided to restore Mehemet Ali's barrage. He did not think Mougel Bey had been such a bad engineer. On all sides the profession severely criticised him, but, confident of his own judgment, Colonel Moncrieff began the work.

First of all, he laid another layer of cement on the old flooring, four feet deep, and doubled its width. He next bored five-inch holes from the top of the roadway, down through the piers, a depth of fifty-seven feet, into the bed of the flooring, where the waters had washed out Mougel Bey's cement. Liquid concrete was then poured into the holes, which were ten feet apart. This concrete, pressed down with great force by its own weight, spread through the washed-out cavities in the foundation, and there became a solid mass.

FINAL SUCCESS IS ATTAINED AT THE DELTA

When this work was completed the gates were closed and they stood the strain of the first flood. The barrage was a success. Then the two canals were finished and water began to flow over the Delta lands. The result has been a yearly increase of the cotton crops in that region amounting to twenty-five million dollars a year.

Since then the English have improved all the old canals of Egypt and extended their reach. They have also built some great storage reservoirs so that the waters of the Nile can be utilised more extensively during the low flood periods. The biggest of these works is the Assuan Dam, considered the most marvellous engineering construction of the kind which has been built in a time of great irrigation works.

THE GREAT ASSUAN DAM HIGH UP THE NILE

The Assuan Dam was built at the head of the First Cataract, 350 miles up the Nile, where the granite bed of the river made an artificial foundation unnecessary. The height of the dam, as first planned, was 127 feet and it was a mile and a quarter wide. It holds back the Nile waters in a basin extending 140 miles upstream, thus forming the greatest artificial lake in the world. The body of the dam is pierced by 180 sluices, each more than six feet wide. These sluices are at different levels and their purpose is to let the first of the floods run through so that the mud will not clog up the reservoir. Later, as the water becomes clearer, the sluices are closed and the reservoir fills. More recently the dam was raised another twenty-three feet.

Much might be told of what the British Government has done in India in the way of irrigation works, on a more extended scale even than in Egypt, though none stands out so prominently as the Delta Barrage and the Assuan Dam. Yet by the digging of many canals the famine areas of the past have been much reduced and some day there will be no region in India where such disasters can occur. But as an illustration of the influence of agriculture on savage peoples the story of the Bari Doab Canal is of interest.

HOW A WHOLE DISTRICT WAS CHANGED

Years ago all the people in this section of the Punjab, a province of India, were wild and warlike, and in the habit of raiding the peaceful farmers of neighbouring sections for plunder. Where they lived the rainy season was unusually short and uncertain. During the good seasons, when the rains extended over a prolonged period, these barbarians worked industriously enough and when their crops were plentiful they did not plunder but let their neighbours alone.

Then the government dug the Bari Doab Canal, to water this region thoroughly. Since then the people have devoted themselves entirely to farming their lands and have developed into a peaceful, law-abiding community. This same scheme has worked successfully in other parts of India as well.

MARVELS OF IRRIGATION IN THE UNITED STATES

But if irrigation has civilised wild tribes in India, it has accomplished even a greater wonder in the United States. It has raised modern, progressive villages and towns out of the sands of unpeopled deserts. Through its magic influence it has changed the howls of the coyote into the hum of trolley cars and displaced the scrubby sage brush with orchards of tropical fruit trees and fields of waving grain. And all this has been accomplished within the lifetimes of most of you who read these lines.

Until quite recently there were vast sections of this country, covering nearly all of the western states, where the climate was too dry for ordinary farming, as practised in the East. The most notable exception was Northern California and parts of Oregon and Washington. Here and in a few other smaller sections more than twenty inches of rain could be depended upon for the cultivation of plant life. All elsewhere is what is known as the arid, or semi-arid, regions.

These climatic conditions are especially marked in the southern part of the West; in the southern half of California, Nevada, Arizona and New Mexico. Here no ancient people had lived to lay the foundation for an irrigation system, to be utilised and modernised by the people of the present day.

Yet there is one exception. One lonely tribe of Indians had suggested the possibilities of the future. For down in Arizona and New Mexico, where the Pueblo Indians still live, there are to be found the ruins of irrigating canals dug by their ancestors. As indicated by these ruins, it is certain that they built dams and long stretches of canal from which to water their crops. In Salado Valley, Arizona, there are over 150 miles of old canals. At De Los Muertos, Arizona, there are more of these old water channels, some of them being seven feet in depth and thirty feet wide. Moreover, it is evident that they were more than mere ditches, for in parts they are lined with baked clay. Evidently the Indians plastered them with adobe, which they baked by building hot fires over it, and the heat transformed the clay into a sort of brick.

EVIDENCES OF INDIAN PROGRESS IN IRRIGATION

And in yet another locality the Indians anticipated modern conditions by installing running water in their villages. Two reservoirs would be built; one above and the other below the village. Between the two trickled a running stream, led into the village square where the Indian women could procure a plentiful supply for their household purposes. What was not so used ran down into the lower reservoir, and thence into the canals that watered the fields.

The first rush of immigrants from the East went to California, not to farm, but to dig for gold. To supply them with food, enough produce could be raised along the river banks. But as the population increased and the prices of plant foods went up, many turned to agriculture as more profitable than mining. Farms sprang up near the mining communities and the farmers began to consider irrigation.

At first their methods were quite simple. The farmers situated some little distance away from the rivers would combine their labour and dig canals; short at first, then more extensive. In other sections, out of reach of the canals, they dug wells from which the water gushed forth in sufficient quantity to irrigate from a few to hundreds of acres. These were the artesian wells.

Once watered the land proved fertile and rich crops were raised. The population continued increasing. Gradually all the lands situated near enough to water sources for cheap irrigation were taken up, and then the irrigation systems became more extensive and more costly. Companies were formed to undertake these bigger works, and some of their undertakings assumed quite a good deal of importance as engineering feats.

One of these private enterprises stands out prominently; its story deserves to be told in the shortest account of Western irrigation.

THE MARVELLOUS STORY OF THE IMPERIAL VALLEY

In the southeastern corner of California there was a stretch of arid desert surrounded by chains of low, rocky mountains, forming a valley about sixty miles long and thirty wide. Not even the coyotes would venture into this bleak district, though when the Southern Pacific Railroad was built it was found necessary to run the tracks through a part of the valley.

One end of the valley, through which there was a break in the hills, was quite near the Colorado River, passing there on its way to the distant ocean. At this point the river is about fifty feet above sea level; thence the floor of the valley descends until the further end of it drops gradually to a hundred and fifty feet below sea level.

A company of young engineers came that way and an apparently wild idea suggested itself to them. Why not turn part of the river in through the gap and so irrigate the valley?

Inspired by their imagination, they formed a development company and began to build a dam. They were successful. The water of the river rose before their dam, then turned through the gap and a steady stream began pouring down the floor of the valley.

HOW THE COLORADO RIVER BROKE AWAY FROM CONTROL

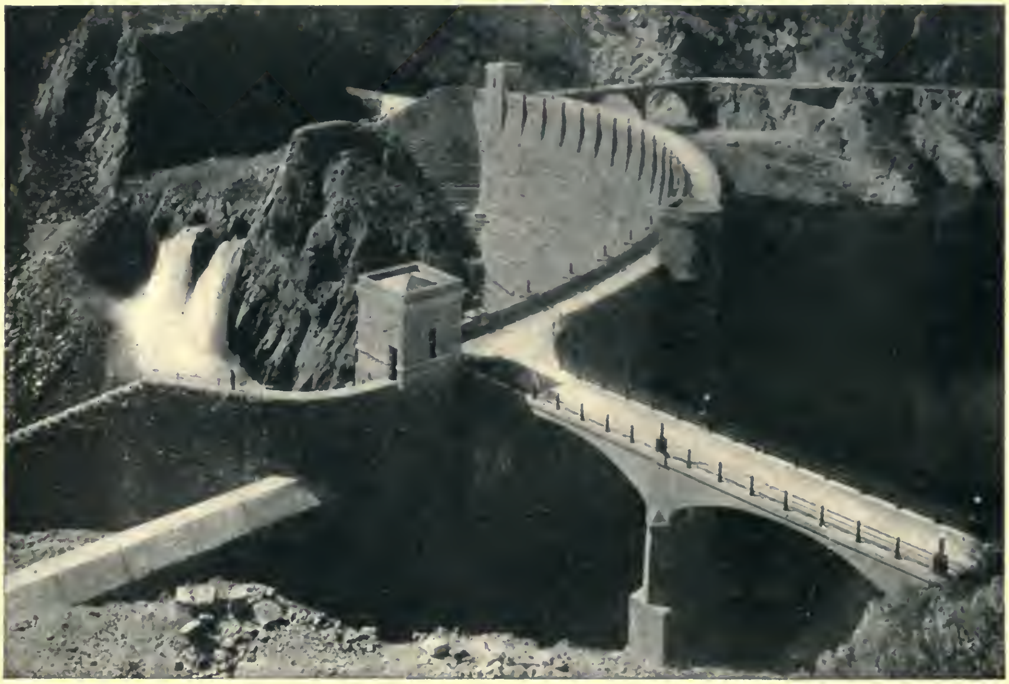
But presently an unexpected calamity took place. The running water began to rip up a deep bed; it acquired more and more force and volume, and before long almost the full flow of the Colorado River was pouring down into the desert valley. Down in the centre was a hollow basin which had probably once been an inland sea. This basin began filling, higher and higher, until the floor of the valley became a vast sea.

Higher and higher rose the water; by this time the engineers had lost control of their enterprise. Then the water began submerging the railroad tracks. They were moved back, but again they were submerged.

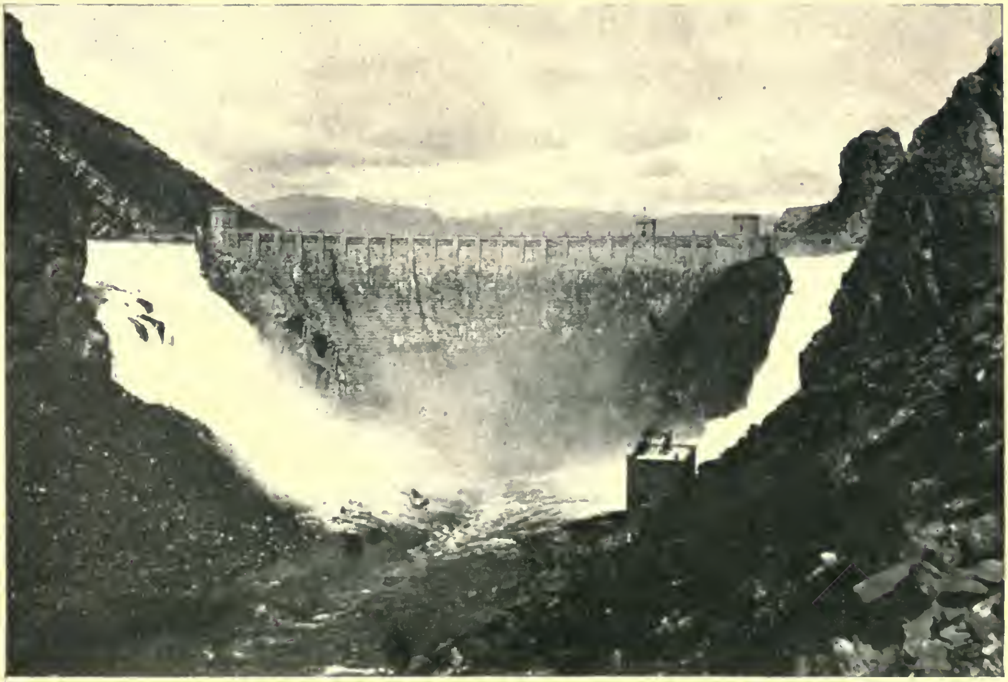
And now the Southern Pacific began to threaten the engineers. They were to blame. The railroad would sue them. But they had not the capital to build works that would turn the river back to its old bed.

Finally the railroad company acquired control. With its wealth it was able to go to work. A strong dam was built, the flow was checked and the inland sea began to subside. Then the original plan was

TWO VIEWS OF THE GREAT ROOSEVELT DAM



The Roosevelt Dam across the Salt River in Arizona is one of the most important irrigation works constructed by the United States. The dam is 1,000 feet long and 280 feet high. The curved side is up stream to meet the current of the water. This shows the reservoir only partly full, and the water escaping through tunnels in the rock. The picture below shows the lower side of the dam.



It was expected that the reservoir would not be filled for several years, but some months of heavy winter rain in the headwaters sent the water tumbling over the spillways at the side. The force of the water is also used to generate electrical power as you can see from the power house. About 250,000 acres of land have been made valuable by the work, adding much to the wealth of the state and the nation.

carried out properly; a canal was dug down the valley and settlers began to flock in to farm.

To-day this old desert, now known as the Imperial Valley, also the "Nile Valley of America," is settled by a community of prosperous farmers, growing wealthy on the produce of their farms. Nowhere in America can such cotton grow as in the Imperial Valley. Six and eight crops of alfalfa in one year may be harvested on the land watered by the canal; the best dates ripen there as they would in the far Orient. Oranges and lemons and grapefruit cultivated there are ready for the market weeks before the citrus fruits of other parts of California are ripe.

In general, however, there came a limit to the extent of the private irrigation enterprises. No group of private persons could build such works as were required to develop the big, arid sections further inland.

It was then, shortly after 1900, that the Government became interested. If the arid sections were to be populated the Government must provide means to make possible agriculture there.

THE UNITED STATES GOVERNMENT TAKES A HAND

So in 1902 the Reclamation Act was passed. This law provided that all the money received for the sale of public lands in the arid, or semi-arid regions, was to be used for irrigation enterprises in those same regions, covering Arizona, California, Colorado, Idaho, Kansas, Montana, Nebraska, Nevada, New Mexico, North Dakota, Utah, Washington and Wyoming. To carry out this great work, equal in its vast scope to the work of the British Government in Egypt or India, the Reclamation Service of the Federal Government was established.

And indeed, though the Service has been in existence only a little over twelve years, it has accomplished wonders. Nearly one hundred million dollars have already been spent in its many irrigation enterprises, covering all the states included in the Reclamation Act. But over seventy thousand people have been brought to the land. Ultimately all this money will be returned to the Government, for one of the conditions is that the farmers who settle on the lands opened up by the Government's irrigation works must organise themselves into co-operative companies which shall eventually acquire ownership of the works, paying back the original cost in small instalments.

The works of the Reclamation Service, either projected, or begun or finished, are too numerous to be described in detail. One of the most important is the dam across the Truckee River in Nevada, from which canals supply water in the Carson Basin and the Carson Sink.

THE GREAT ROOSEVELT DAM IN ARIZONA RECENTLY COMPLETED

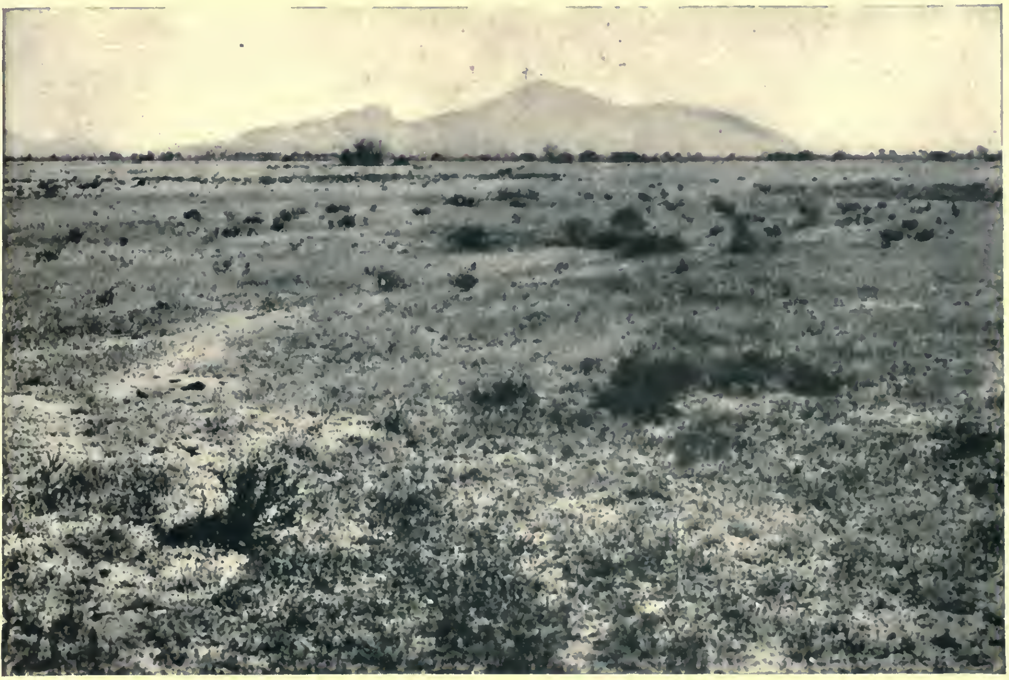
The enterprise most worthy of mention, however, is undoubtedly the damming of the Salt River, in Arizona, sixty miles above Phœnix, which was completed in 1911. At this point, deep in the wilderness, there is a narrow gorge in which the Service has constructed a dam 280 feet high and over a thousand feet wide, thus forming the Roosevelt Reservoir, an artificial lake twenty-five miles in length and 220 feet deep. Nearly half a million barrels of cement were used in constructing the masonry. The water is let out of the reservoir, through a tunnel in the solid rock, leading around the dam, whence it runs down the bed of the river for forty miles before it is led into the canals. About a quarter of a million acres of what was once sage brush land has been, or is being, converted into fertile farms on which are already growing groves of date palms and orchards of luscious citrus fruits. One industry that the canals from the reservoir has developed is ostrich raising.

It is estimated that it will take two hundred years before the Roosevelt Reservoir is filled up by the sediment from the river. But even when this time approaches, it will not pay to clean it out; it will be much cheaper to add to the height of the dam, for every ten feet added will enable it to endure another twenty-five years.

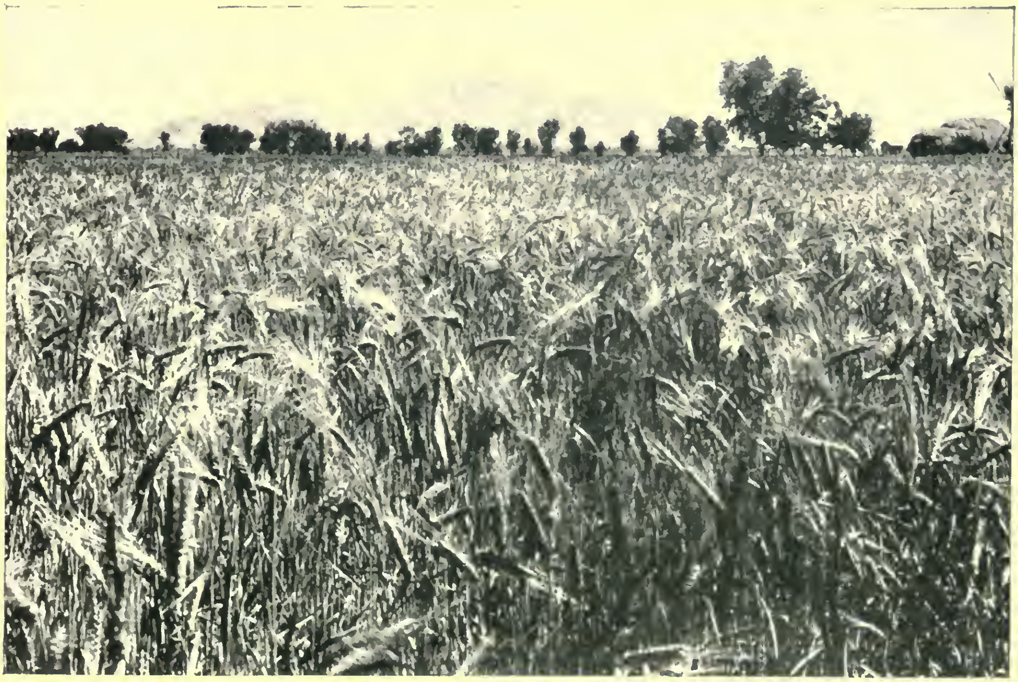
INDIANS COME TO SEEK EMPLOYMENT ON THE WORK

An interesting feature of the construction of the dam was the arrival of a band of Apache Indians, who asked to be put to work. At first, because of the poor food they were used to, they were no

WHAT WATER WILL DO FOR BARREN GROUND

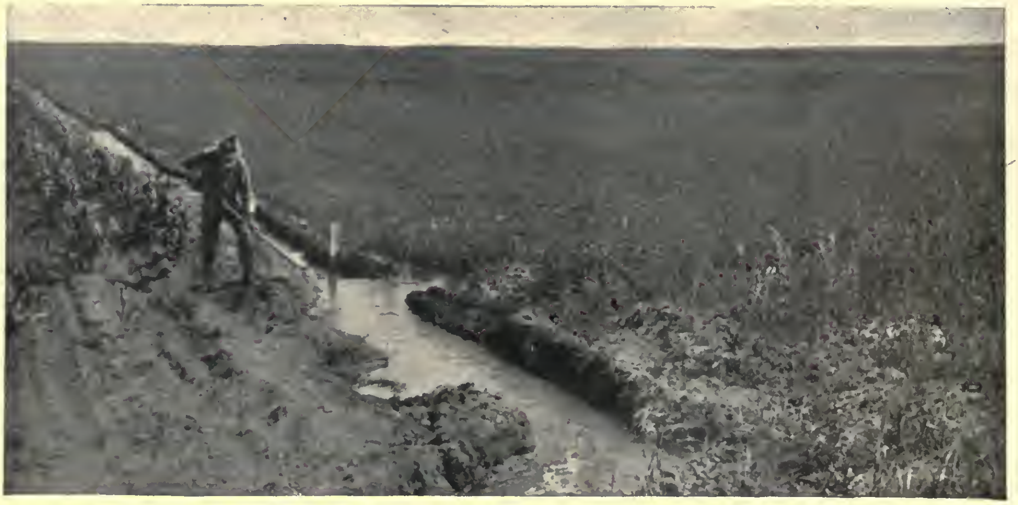


This barren land has all the elements necessary for plant growth present in the soil, but the sparse vegetation shows that something is lacking. Only a small amount of grass and some straggling bushes struggle to live. There are thousands of acres like this in Western United States. Only water is lacking to make the desert blossom.

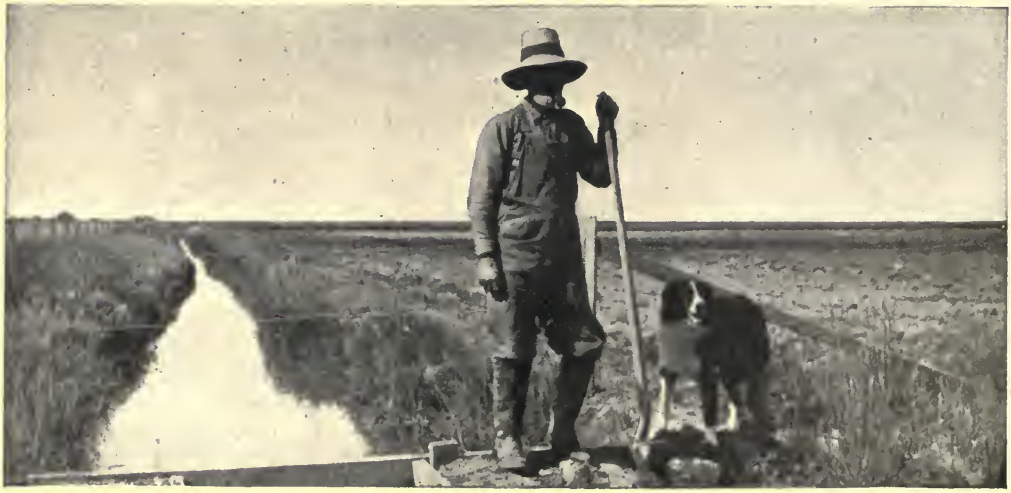


This is the same field some time afterward when water has been turned upon the soil. Notice the luxuriant growth of wheat in the foreground, and the signs of human life in the background. Thousands of acres of worthless land have been made fruitful by the application of water. Notice the mountains in the background of both pictures, and the line of trees which show that the places are the same.

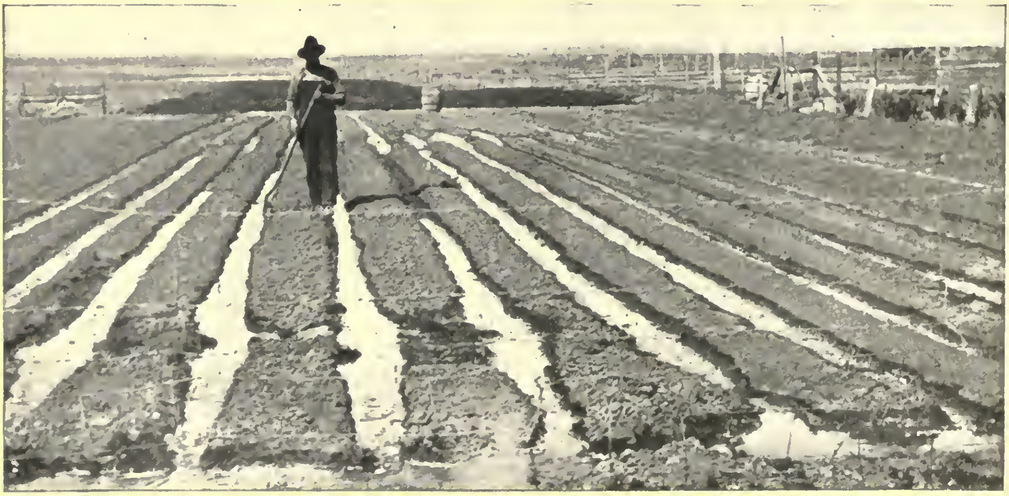
SCENES IN THE BOW VALLEY IRRIGATION BLOCK



A LATERAL OR SIDE-DITCH THROUGH A FIELD

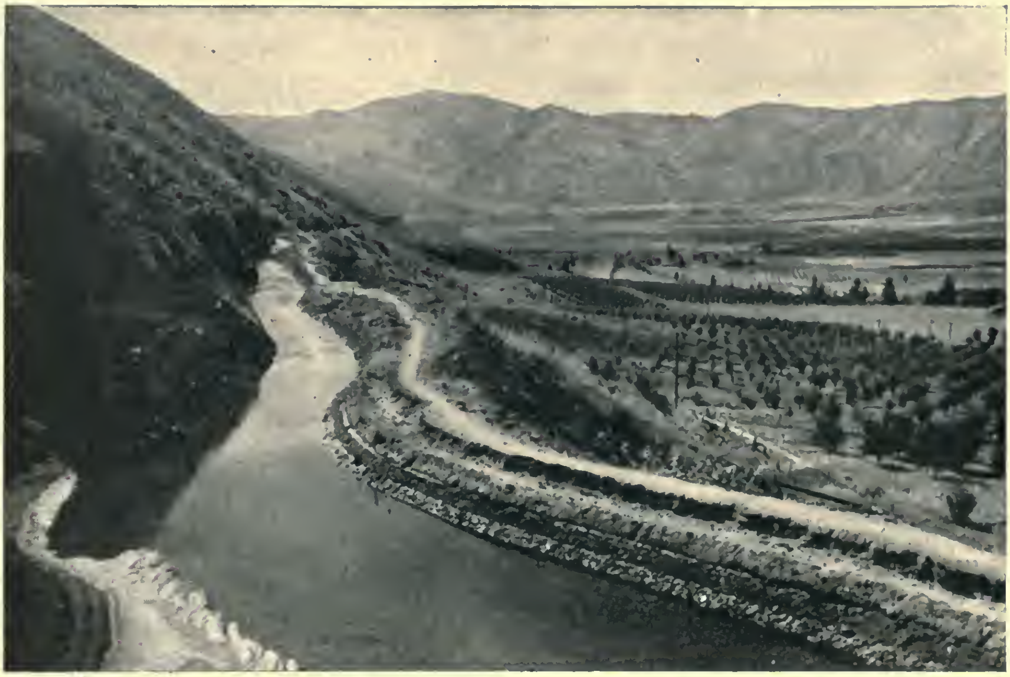


A DAM TO HOLD THE WATER BACK AND DIVERT IT THROUGH A FIELD

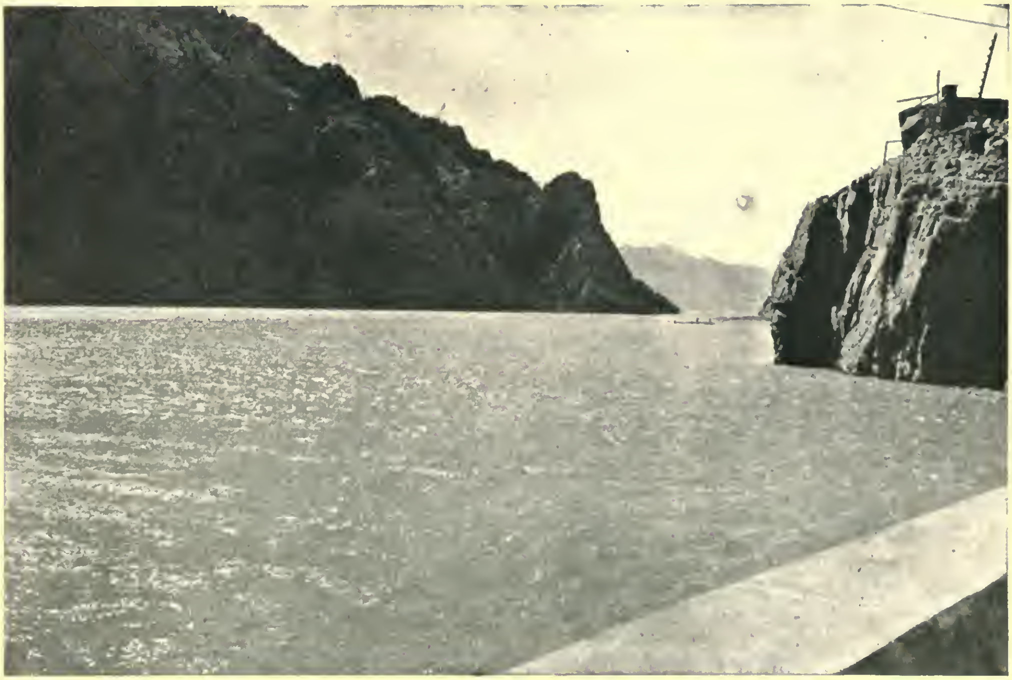


THE FARMER DIGS DITCHES AND RUNS THE WATER THROUGH THEM

IRRIGATION IN TWO WESTERN STATES



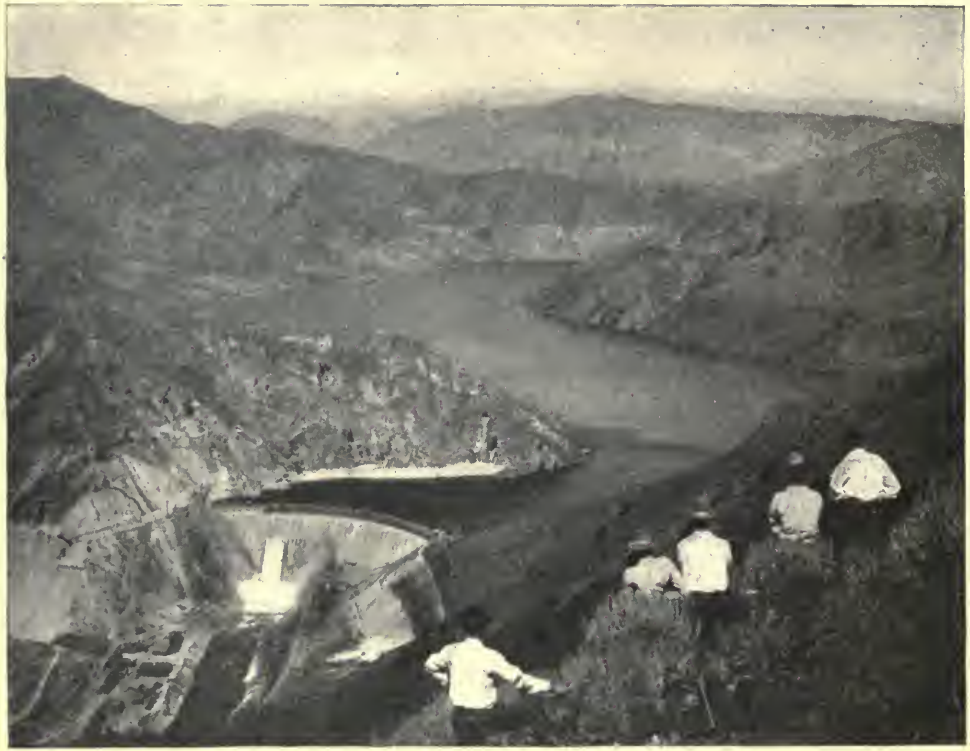
This picture of an irrigation ditch near Cashmere, Wenatchee Valley, Washington, shows how water may be distributed over the fields and orchards. The bank of the ditch is pierced and the water is conducted where it is needed, by means of small ditches or troughs. To the right are seen the orchards which have helped to make Washington famous. The apples of Washington and Oregon are especially noted.



The Shoshone Reservoir is in Big Horn County, Wyoming, near the town of Cody. This interesting picture was taken from the top of the dam, a part of which shows as a white band to the right. This is a project under the control of the United States government, and has brought much land under cultivation.

match for the white labourers and were paid smaller wages, but with good food they became stronger, until finally they were paid the same wages as the whites. Among these Apache wielders of the pick and shovel were several old braves who had been on the warpath with Geronimo.

The work of constructing one of these great engineering projects is often difficult, and many problems arise. For example, the whole flow of the Boise River was diverted into tunnels driven through the rock, while the great Arrow Rock Dam was in process of construction.



THE GREAT ARROW ROCK DAM IN IDAHO

This dam is on the Boise River, near Boise, Idaho, and in its construction exhibited many unusual features. It is more than 348 feet from foundation to the top, and is therefore the highest dam in the world. It is more than a fifth of a mile long and the backwater extends twenty miles up-stream, forming a beautiful mountain lake. The stored water is carried down stream twelve miles before it is diverted to the land. The whole project cost the United States Government $12,000,000, which will be collected in twenty annual instalments from those who use the quarter of a million acres of worthless land made valuable by the stupendous work.

Just what effect the irrigation works of the Government have in attracting settlers to the land is illustrated in a story told by one of the Reclamation Service officials. He was out riding in Montana, near one of the sites where construction had recently been begun. Suddenly he came upon a large, two-story house, built among the sage brush. He was so interested that he dismounted from his horse and prepared to photograph the house. At this point the owner came out and invited him to come inside. And then, to his intense surprise, the official found himself in a modern, well furnished home, fitted with electric light connections, with hot and cold water plumbing.

"But what use can you make of all these contrivances, out here in the sage brush?" demanded the official. "It will be two years before the dam is finished. Meanwhile there isn't a drop of water nearer than the river."

"That is true," replied the settler, quietly: "we can't use these things now. But when the time comes, two years from now, we shall be the first house in a modern town, with trolley cars passing our door. Meanwhile we are quite willing to haul our water ten miles from the river."

THE ERIE CANAL

ONE OF THE EARLY IMPORTANT CANALS OF THE UNITED STATES

BEFORE the steam engine was invented and railroads were built cities and towns were chiefly found near the sea or along the rivers. The ancient nations that first became civilised inhabited regions about the big waters. Babylon was on the Euphrates, the Egyptians lived on the banks of the Nile and the Greeks inhabited the islands and the shores of the Ægean Sea. England, surrounded by sea and watered by rivers, was the first country in Northern Europe to become densely populated.

The reason is simple. In those days water was the only practical means of long distance transportation. Manufacturing, even of a primitive kind, was impossible away from the water because the manufacturers could not ship their wares to the markets. For the same reason it did not pay the farmers to raise more produce than they themselves could consume. There were a few exceptions, such as the cattle raisers; they could drive their cattle to market over long distances. Their produce transported itself.

EARLY TRANSPORTATION BY WATER

The manufacturers and the farmers near the water could produce larger quantities, for they could load their wares and their produce on boats or ships, at comparatively little expense, and send them even to other countries. Consequently all manufacturers and farmers wanted to be near the water. It was trade that developed civilisation, but it was water transportation that made trade possible.

Railroads have since changed these conditions. Without the railroads the interior of our vast country would still be wild prairie and forest. Freight cars serve on land as ships serve on the water, but water has not lost all of its old time importance. Even to-day there are few really big cities far inland.

But at the time the American colonies had freed themselves from England, and for long afterwards, there was no thought of railways. Steam had not yet been put to practical use. The population of the new United States was then confined to the Atlantic seacoast and the river valleys. Boston, New York and Philadelphia had become the most important cities because they had protected harbours for shipping.

Meanwhile there had been some migration westward, through the wilderness. The regions bordering on the shores of the Great Lakes and along the many rivers feeding them consisted of low, rolling country, especially adapted to the raising of grains.

MEN LOOK TO THE WEST

Very early in the history of our country, there had been far-seeing men among the colonists who saw the tremendous advantages to the colonies that would follow establishing some means of transportation between the rich, agricultural regions west of the Alleghanies and the Atlantic seacoast. The lands along the coast were not adapted to wheat growing, yet the population needed wheat. With easy transportation the farmers of the West would not only be able to supply this demand, but they would also be able to export their grains to Europe. Such a route would also render the wilderness between New York and the lake country habitable, for the settlers along the way would also be able to ship their produce to market.

George Washington, practical surveyor and engineer, was one of the first to have his imagination roused by these possibilities. He had explored the country between Albany on the Hudson and Buffalo on Lake Erie. Already much of this region was traversed by water routes. He became an enthusiastic advocate for connecting these waterways by canals, so that boats might pass from New York to the interior. To him it was not only a question of trade. If the sturdy settlers who had cleared their little homesteads in the western wildernesses were not offered a means of communication with the states in the East, they would turn toward the power which held the Mississippi. Give them an outlet to the Atlantic coast and they would naturally maintain their allegiance to the States. To Washington and many others a waterway from the Great Lakes to the Hudson was necessary to develop a great, united nation.

Possibly it was only those of big, broad

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minds who saw it from this point of view. More numerous were the merchants and tradesmen of New York who, for more selfish reasons, agitated the idea with much energy. They feared the commercial rivalry of Boston and Philadelphia. With western grain, exported to Europe, passing through New York, that city would become the great trade centre of the country, its most important seaport. They finally compelled the State legislature to take action.

FIRST DISCUSSION OF A GREAT CANAL

In 1791 the legislature had ordered a survey made. Engineers were sent to study the country between Albany and Lake Erie and report on the possibility of digging a through waterway between those two points. Their report was warmly in favour of the undertaking. And so the first actual step was taken toward the digging of the Erie Canal.

Travellers of that period have left interesting records of the difficulties to be encountered on the way. From New York City they journeyed from two to five days on sailing boats up to Albany, thence overland seventeen miles to Schenectady. Here they embarked again on boats, propelled by oars and sail and sometimes, over shallow stretches, by means of poles. After travelling 104 miles in this fashion, at the rate of about twenty miles a day, they would reach Utica, a small, log hut settlement. Another nine days' journey by water and land brought them to Oswego, on Lake Ontario. Naturally very little merchandise was sent over this route, but such as was sent cost $100 a ton for freight.

PRIVATE INDIVIDUALS FAIL TO DIG A CANAL

At first the State attempted to encourage private companies to undertake the vast work of cutting through the waterway. Some were organised and even began work; short sections of canal were dug, connecting some of the various rivers and lakes on the way. But in those days there were few rich men and it was found impossible to raise enough capital to finance the whole undertaking.

One of the most enthusiastic advocates of the scheme was Gouverneur Morris, then representing New York in the United States Senate. "Some day," said he, "ships will sail from London bound for Buffalo, via the Hudson River." It was he who interested DeWitt Clinton in the idea, the man whose determination and energy was yet to bring it to a complete realisation.

It was nearly twenty years after the first survey had been made before the State again took action. By this time it was obvious that the private companies could not accomplish much. So, in 1810, the Legislature appointed a Canal Commission to go to Washington and lay the matter before the President and Congress. As George Washington had already said years before, an Erie Canal was of great national importance; it would unite the nation; the East with what was then the West. The cost had been estimated at five million dollars. Private capitalists could not subscribe such an amount, but surely Congress could appropriate such a sum for a work of such importance.

DE WITT CLINTON AND THE ERIE CANAL

But in those days Congress did not make five million dollar appropriations so readily as it does now. There was much discussion and powerful opposition. Then came the War of 1812 and the Federal Government had other matters to which it must devote its energy and funds. It was then that DeWitt Clinton began publicly to agitate the digging of the canal. And finally, in 1816, the Governor of New York appointed a new Canal Commission, authorised to raise a loan which would be guaranteed by the State. At the head of this commission the Governor placed De Witt Clinton.

To test the interest of the people of the State in the canal scheme Clinton made it a political issue; in the following year, 1817, he became a candidate for Governor, promising that if he were chosen he would make the digging of the canal his chief business. And he was elected, by one of the biggest majorities that ever put an official into office. On July 1 he was inaugurated. Three days later, on Independence Day, he went up to Rome, on the Mohawk River, attended by his staff; and began the digging of the canal by turning up the first shovelful of earth.

According to the plans the canal was to be forty feet wide at the top, twenty-eight feet at the bottom and four feet deep.

The cost would be about five million dollars. It was the size of the work that was most remarkable; as a feat of engineering skill it was then unusual, but, when compared with the great works that are undertaken in the present time, it was not especially difficult.

Yet there were many supposedly well educated people in those days who thought the Erie Canal a wild dream. "You cannot make water run uphill," they said, though the theory of locks, by means of which barges could be lifted to higher levels, had already been put into practice in canals abroad. The digging began. In two years a section fifteen miles in length was finished, connecting Rome with Utica. The next year the canal reached the Seneca River.

THE CANAL IS FINALLY COMPLETED

DeWitt Clinton had said that the work would be completed in 1823, but this promise was not fulfilled. It went more slowly than had been expected. His political enemies made the most of this in the next gubernatorial campaign. In spite of this he had been re-elected to a second term, but by a very slender majority. Plainly the people were growing discouraged with the slow progress of the canal work. At the next election, in 1822, Clinton had not even been nominated as a candidate. His opponents came into office, though he remained the head of the Canal Commission. And then the Governor removed him from that office, which he had held since 1810, even while Governor. His enemies, those who had been against the canal from the beginning, a political ring known as the "Albany Regency," seemed to have triumphed. After this humiliation it was thought that Clinton's public career was ended.

But the man who had transformed talk into action was not to be overcome so easily. Under the Albany Regency the work on the canal almost came to a standstill. This caused even more dissatisfaction than the slow progress. So two years later, in 1824, Clinton found himself with enough friends to be nominated as candidate for Governor once more. And when the election came around he was again put into office by a great majority. Once more in office and at the head of his old Canal Commission, he began pushing the work with renewed energy. And a year later, October 26, 1825, the work was completed and the opening ceremony was celebrated.

CEREMONIES WHEN THE CANAL WAS COMPLETED

The first boat to enter the canal at Buffalo was the *Seneca Chief*, a luxurious passenger packet. On board were Governor Clinton, his family, his friends and his official staff. A team of four powerful grey horses hauled it along, and as they began treading the towpath, a cannon at the entrance of the canal announced the official opening. A minute later another cannon boomed forth, some miles away, then a third, far off in the distance, almost beyond hearing.

These cannon were the first of a series of several hundred cannon, stationed at intervals along the canal, reaching down along the Hudson to New York, each barely within sound of the other. And so the news of the opening was flashed down to New York, as fast as sound could travel, passing down the line in one hour and twenty minutes.

Following the *Seneca Chief* into the canal came a procession of barges, each gaily decorated with flags and flowers, crowded with people. One, called *Noah's Ark*, carried as passengers a bear, two fawns, two eagles, two raccoons and two Indians. And so the procession continued along the canal toward Albany. All along the route it was met with music and cheering crowds of farmers, most of whom had settled in anticipation of the benefits they would derive from the canal.

At Albany the barges were greeted with the booming of cannon, a grand military procession and a citizens' parade. Here the flotilla of barges glided into the Hudson and began its journey down the river to New York. The *Washington*, a new steamer, one of the first afloat on the Hudson, came up to meet them. "Where are you from and whither bound?" it signalled.

"From Lake Erie, bound for Sandy Hook," replied the *Seneca Chief*.

The *Washington* and the *Seneca Chief* leading, the procession continued, passed New York to the sound of ringing bells and booming cannon and continued down the harbour toward the Narrows.

The journey from Buffalo had taken just nine days.

THE WATERS OF LAKE ERIE MINGLE WITH THE OCEAN

Outside the Narrows the flotilla paused. Then the Governor lifted a keg, containing water from Lake Erie, which he poured into the Atlantic Ocean, to signify the union of the two waters. Another keg, containing a mixture of waters from all the great rivers of the world, from the Ganges, the Thames, the Nile, the Amazon, was also poured over, to indicate that the commerce from all parts of the world would now pass that way. As the Governor pronounced the official address tears streamed from his eyes. For twenty years he had talked and worked for the canal, at times apparently on the verge of failure. Now he had triumphed.

The celebration that welcomed the Governor and his companions in New York City exceeded anything of the kind that had ever taken place before. Military and citizens' parades thronged the streets. All the trades were represented, the fire department leading. Heading the marching printers was a wagon carrying a printing press. And as the procession marched the press turned out leaflets bearing the printed verse:

"'Tis done! 'Tis done! The mighty chain
Which joins bright Erie to the Main,
For ages shall perpetuate
The glories of our native state."

The Erie Canal more than realised the expectations of those who had advocated its construction years before. Even as a mere business enterprise it proved a success from the beginning. In 1825, the year in which the work was completed, the tolls collected along the finished part of the route amounted to over half a million dollars. Five years later, in 1830, the State collected a million dollars in tolls. By the end of 1837, only twelve years after it had been opened, the Erie Canal had paid fifteen million dollars into the treasury, which was more than the cost of digging and maintaining it in repair combined.

WHAT THE CANAL DID FOR NEW YORK CITY

For the business interests of New York it had done even more. In 1824, the year before traffic was opened along the whole canal, it cost $88 to send a ton of freight from Buffalo to Albany. Eleven years later, in 1835, it cost only three dollars. This meant that the people of New York and up and down the coast could get their bread so much cheaper. It also enabled the poor people of Europe to get their bread cheaper, for now vast quantities of wheat were shipped down the canal and exported to Europe. Over half of all the wheat exported from America to Europe came by this route. It was the Erie Canal which made New York the biggest business centre on the Atlantic Coast, the most important seaport in the country.

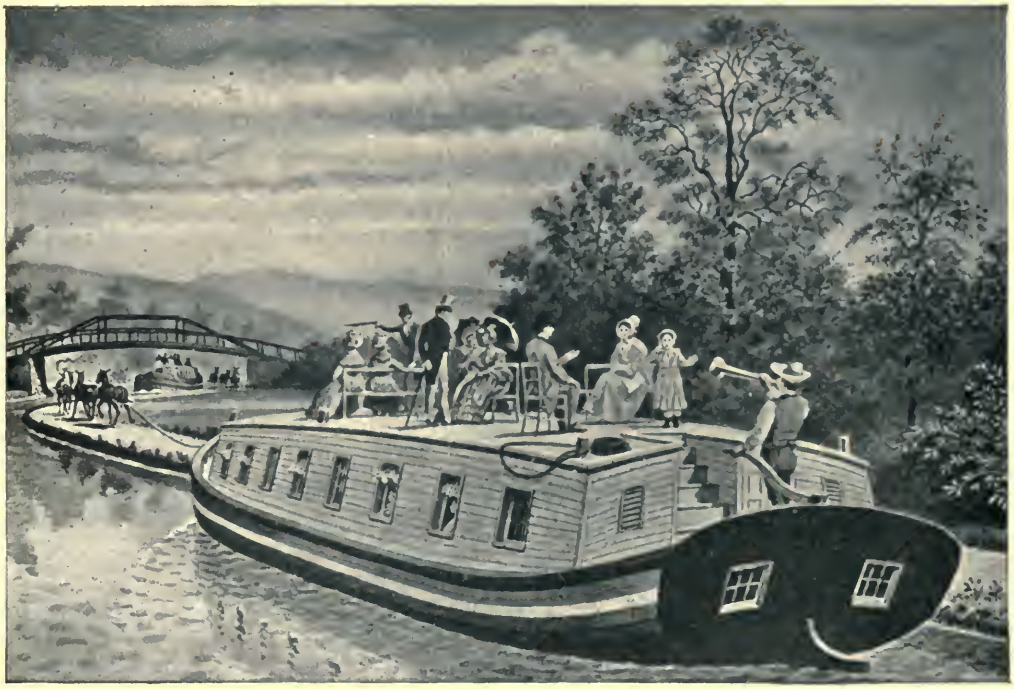
THE CANAL HELPED THE STATE

With a navigable waterway traversing it, it was only natural that New York State should develop. What was once a wilderness, through which the early settlers had passed to reach the Great Lakes region, now became covered with prosperous farming communities. Even before the canal was completed the immigrants had arrived to lay out their homesteads, in anticipation of the produce they would be able to raise for the New York, Boston and Philadelphia markets. Just what effect the canal had in populating the State may be judged from the fact that nine-tenths of the people lived along its route, or close to it. Not only was the canal a big success, but the people realised it. For again they elected DeWitt Clinton Governor of the State; he died in office, in 1828.

Already while the canal was being dug there was talk of wagons that should run on iron rails, drawn by steam engines, and in 1831 a railroad was actually built from Albany to Schenectady, a distance of seventeen miles. Ten years later the railroad had been extended to Buffalo. But the railroads did not have any great effect on the traffic on the canal. For the reason that it costs so much to build and maintain railroads and freight cars water transportation is and always will be cheaper.

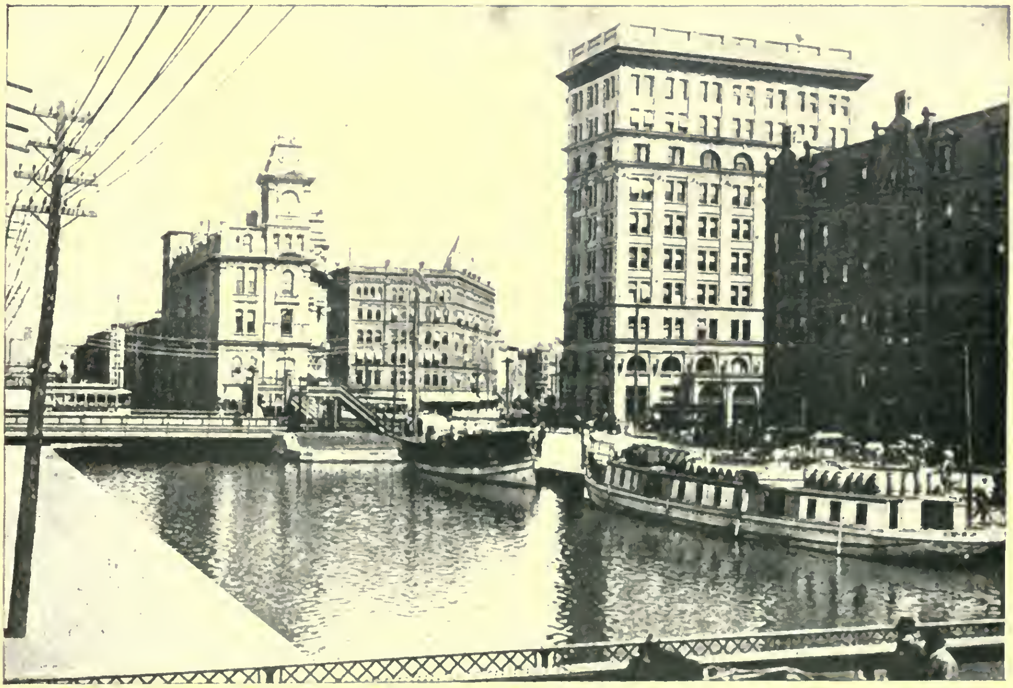
THE CANAL WAS WIDENED AND DEEPENED

It is usually said that the Erie Canal was completed in 1825. But that is not quite true. It is not yet completed. Within ten years there was more freight than the canal barges could handle. Branches



TRAVELLING ON THE ERIE CANAL ABOUT 1835

Before railroads became common, many passenger boats were built for the Erie Canal, and were very popular. This picture made from a water-colour of the time shows the boat drawn by three horses going smoothly at the rate of four or five miles an hour, while the passengers talked, read or looked at the scenery. Sleeping quarters were arranged below.



THE ERIE CANAL IN THE HEART OF SYRACUSE

Flourishing cities grew up along the canal and in several cases the canal is now bordered by high buildings and busy streets. Here we see boats loading and unloading in the heart of the city of Syracuse. Progress is necessarily slow as many bridges bar the way and must swing aside or rise to allow the boats to pass.

reaching out into other districts were continually being dug until there were over a thousand miles of canal. Then the main canal was widened to 70 feet, so that barges large enough to carry eight thousand bushels of wheat could pass, instead of only one thousand bushels.

It was not long before the railroad companies began to show a bitter opposition toward the canal. Naturally, the canal forced them to keep down their freight rates. In every way they could they tried to impede any improvements on what they called the "ditch." Through their efforts a law was passed abolishing tolls. Apparently this would make freight rates cheaper on the canal. And so it did. But it also abolished the source of revenue from which improvements could be made. This obliged the legislature to appropriate special sums of money for the purpose. And this again raised a strong sentiment against the canal among those who did not benefit directly from it and felt they were being taxed for the good of those who lived along its route. The consequence was that the canal was neglected.

AGAIN THE CANAL WAS IMPROVED

But finally, in 1903, the people awoke to the realisation that the railroads were opposed to the canal only for reasons of self-interest. And then amends were made for the many years of neglect. The legislature voted in favour of spending one hundred million dollars to build what will practically be a new canal, but a modern one, along which steamers may sail as they do up and down the Hudson.

For twelve years this gigantic work has been going on; it is now near completion. Because the Panama Canal was being dug at the same time, and all public attention was being directed toward this great engineering feat we have not heard very much of the canal digging in New York. But in many ways the engineering being done on the Erie Canal quite equals anything that was being done at Panama, and in some respects it is more wonderful.

The system of locks along the new Erie Canal will surpass even the Panama locks. In a dry, sloping pasture behind the little town of Waterford the engineers have built what looks like a flight of giant steps, huge, concrete blocks, in each of which is one of five locks. Combined they will lift the freight steamers 184 feet, which is fourteen feet higher than all the Panama locks combined. At Little Falls, where the new channel of the canal will ascend a narrow ravine, there is one lock, the highest in the world, which will lift the steamers 42 1-2 feet in eight minutes, as though they were being hoisted by a giant derrick.

SOME WONDERFUL FEATURES OF THE WORK

Another wonderful feature is the great movable dams, big steel girders and steel plates riveted together, which are hinged on gigantic bridgelike structures. When navigation ceases in the winter these dams will be swung up so that the ice floes may sweep down unimpeded. There are eight of these great dams, and each costs $800,000.

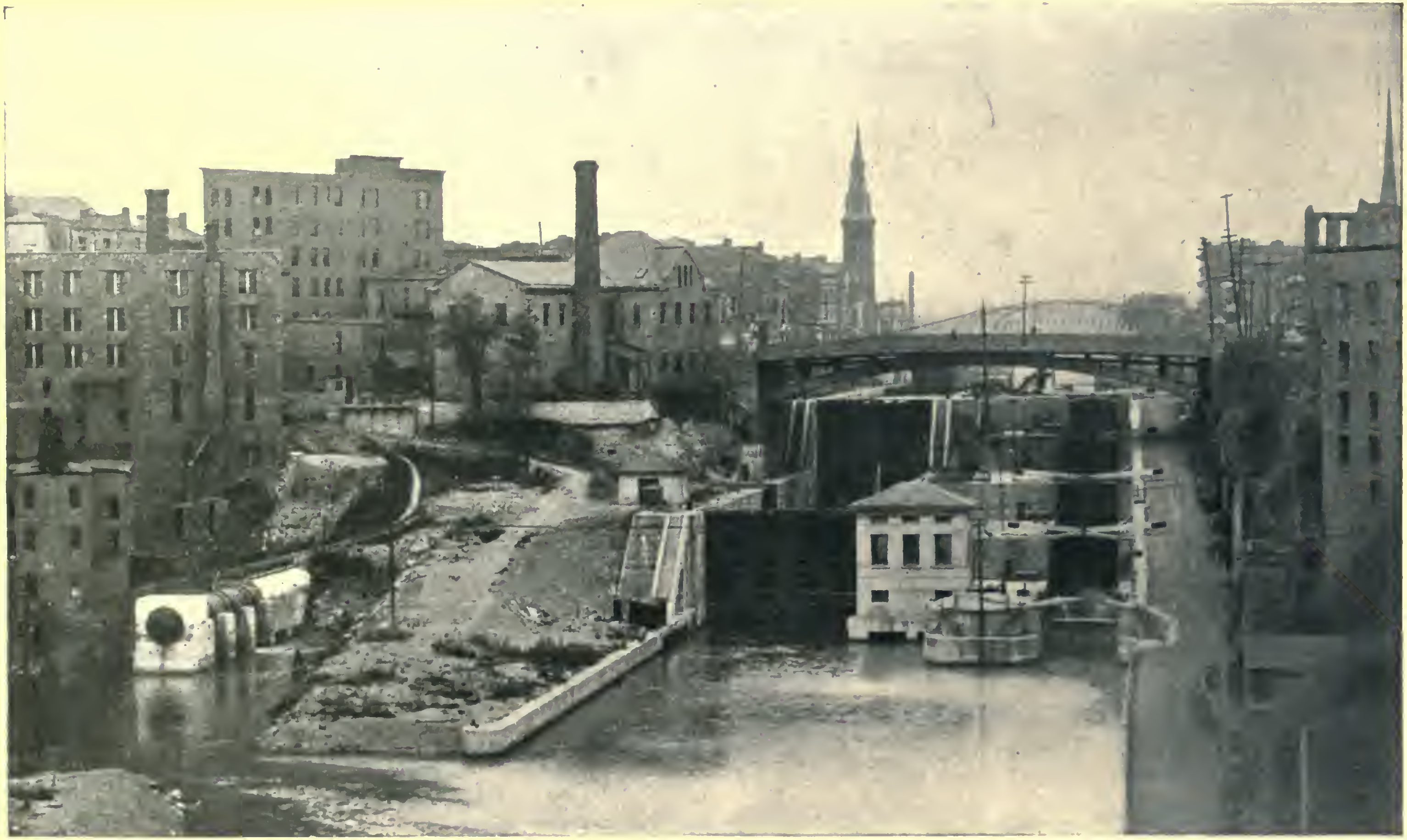
The barges which are to take the place of the old horse-hauled craft will be of 3,000-ton burden, as compared to the 250-ton burden of the old barges. Each will be able to carry the contents of a freight train of seventy-five cars. That is the size of an average ocean-going freight steamer. And being propelled by their own power, these modern freight carriers will be able to carry their cargoes from Buffalo to New York two and a half times faster than did the old barges; the trip will be covered in two or three days.

THE NEW CANAL A GREAT UNDERTAKING

Though it is only one of the states of the Union, New York, which is carrying out this vast undertaking, it must really be regarded from the viewpoint of its national importance. It is, in fact, one of three such feats of construction, of which it ranks at least second. And all three have been planned wholly, or partly, to open wider the markets of Europe to the great grain fields of the West.

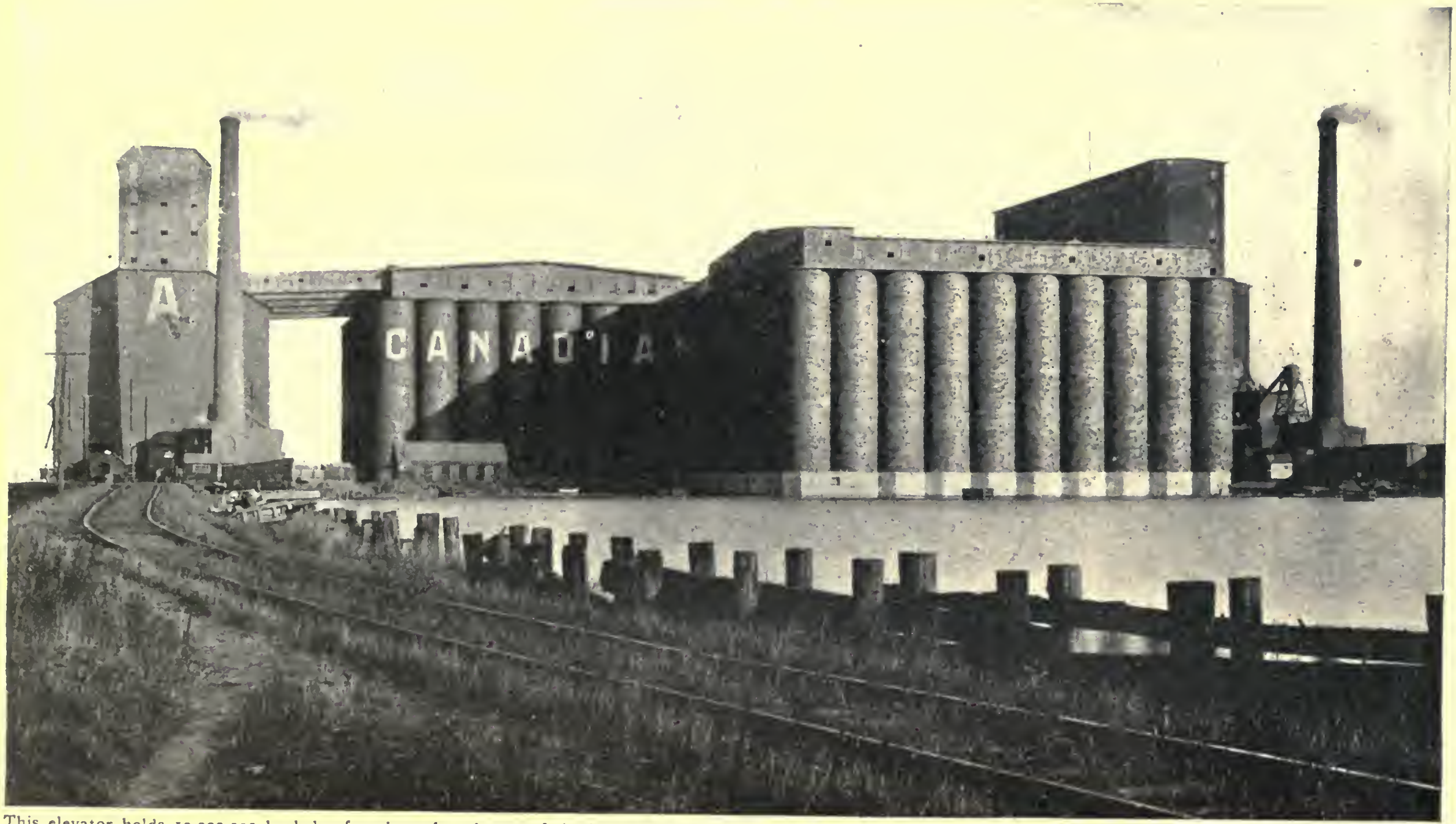
The first of these three is the Panama Canal. Until that was opened wheat was shipped from the West to Europe by Cape Horn. The Panama Canal will enable steamers to carry it in much less time. The other is an enterprise being undertaken by the Canadian Government: the digging of a series of canals from the Great Lakes down around the St. Lawrence Rapids, thereby opening a waterway direct to Europe from the interior of Canada.

THE GREAT LOCKS OF THE ERIE CANAL AT LOCKPORT



While these locks are not so large as those of the Panama Canal, they are still unusually interesting. They are in the little city of Lockport in western New York, where the land descends toward the level of Lake Erie. These, however, are not the largest on the canal. At Little Falls is the highest lock in the world, and at Waterford is a set of five, which together raise or lower the boats the immense distance of 184 feet. The total lift of the Panama locks is not half so much.

THE CANADIAN NORTHERN ELEVATOR AT PORT ARTHUR, ONTARIO



This elevator holds 10,000,000 bushels of grain and each one of the huge, cylindrical, concrete bins holds several thousand bushels. It is called an elevator because the wheat is elevated, or raised, to the top of the building before it is dropped into the bins. Wheat is stored here until it is sold. In the picture you see where the cars are run into the elevator. The grain is taken from the cars to the top of the building in hoppers and there weighed and distributed to the bins. Six hundred cars, averaging 1,000 bushels each, can be unloaded in one day. When the wheat is shipped, it is taken from the bottom of the bin, elevated to the top of the building, weighed, and spouted into the hold of a lake vessel. In this way 100,000 bushels can be unloaded from the elevator in one day.

THE PALACE OF MAGIC

THE IMPOSSIBLE THINGS THAT ARE MADE TO HAPPEN IN THE CINEMATOGRAPH

CINEMATOGRAPH TRICKS AND HOW THEY ARE DONE

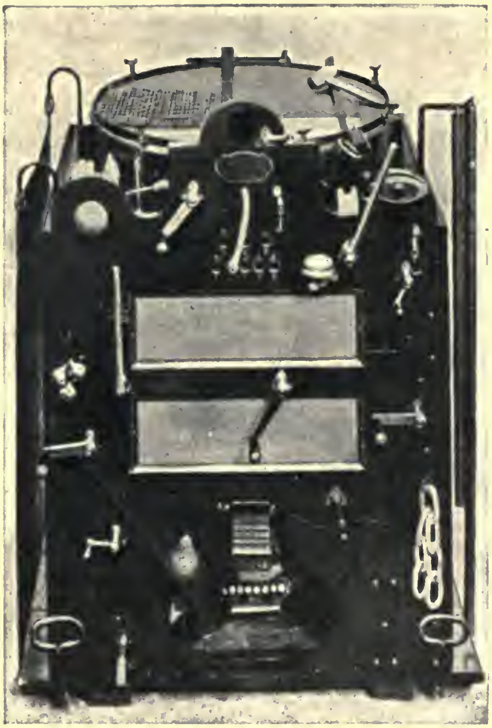
SCATTERED about the cities and towns of the world are thousands of gay and bright buildings in which the strangest and weirdest things are continually happening. An ordinary man sits down to lunch at an ordinary table, but when he cuts his roll of bread a fairy jumps out—a little tiny living creature who dances in the prettiest way. While the astonished man is watching her, everything around him becomes alive. Little elves leap out of the things on the table and begin a wild frolic. The table itself joins in the dance, and the chair on which the man is sitting tilts him off and hops about the room. If the man tries to stop the furniture from dancing, worse things happen, for the chairs will attack him and drive him out of the house. The sofa drags itself along on its short legs like a crocodile; the chairs leap like frisky goats; and here and there a little stool trots along like a rabbit—all of them engaged in driving the terrified man out into the street. There they pursue him, in and out of shops and over walls, to the utter amazement of all the passers-by.

We can see all this take place before our very eyes, and even stranger scenes occur in these palaces of modern magic, which are usually called moving-picture shows. And the wonder is how it is done. We all know how the ordinary picture play is made. Some actors and actresses dress themselves up for their parts, and act some story, either in a theatre or in the open air, while a man photographs them at great speed. These photographs are printed small on a long ribbon of transparent material, and in the picture palace this ribbon is moved rapidly in front of a new kind of magic lantern. An intense beam of light shines through the moving pictures, and throws them on to the large screen on the stage. By keeping the pictures moving before our eyes at a speed of sixteen a second, the operator of the magic lantern gives us the illusion of seeing living figures in action.

But, marvellous as all this is, it is not so strange, wild, and puzzling as the magical scenes revealed by the cinematograph. Some time ago the writer saw in a picture palace a tired and sleepy workman coming home from his work. He was walking down an empty country road, and he felt so tired that at last he threw himself down in the middle of the roadway, stretched himself out at full length, and went to sleep. Suddenly a motor-car came tearing along, and before the driver could see the sleeping workman the car had run over him and cut both his legs off. But disasters of this sort are easily remedied in picture-palace land. A doctor jumped out of the car and stuck the legs of the man on to his body, lifted him up, shook hands with him, and sent him off as if nothing had happened.

This is what is called a trick picture. It was not at all difficult to arrange. Four actors and a photographer drove out into the country, and stopped on a dusty high-road where there was scarcely any traffic to interfere with them. One of the actors was dressed like a working man. He stretched himself at full length in the middle of the road, and pretended to go to sleep, and the motor-car, with two actors dressed as doctor and driver, came flying down the road, the dust rising around it. But it slowed down as it approached the sleeping figure, and stopped when the front wheel just touched the legs of the outstretched actor.

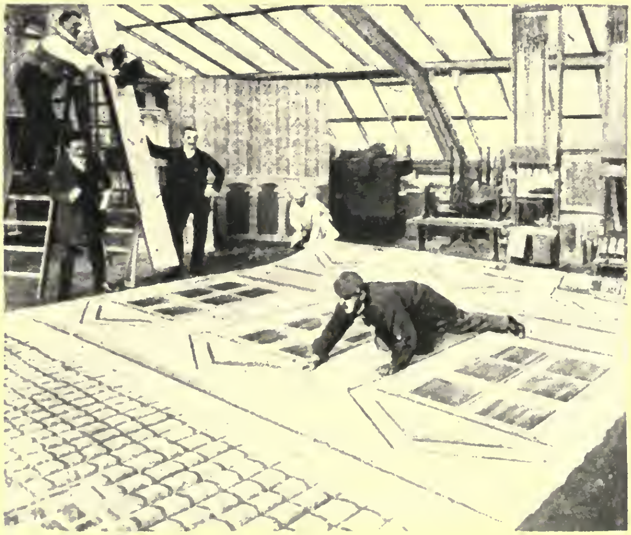
All this time the photographer had been busy taking photographs of the scene at the rate of sixteen a second. Now, however, he stopped his camera from working, and put a lid over the lens. Then the fourth actor, who had hitherto kept out of sight, made his appearance. He was a man who had lost his two legs by an accident, but he was now provided with two false limbs. With the help of the other three actors, he placed himself before the motor-car, in the same attitude as the sleeping man had adopted, and his false legs were arranged so that they would fall apart from his real body at a push from the wheel of the motor-car.



A MACHINE THAT MAKES FIFTY KINDS OF NOISES FOR CINEMATOGRAPH PICTURES

The dust on the road was then carefully brushed up and scattered, to efface all the footmarks. The first actor disappeared for a while from the scene; the doctor and driver got back into the car; and, just as the car began to move, the photographer set his camera again working. So the apparently dreadful accident was recorded in moving pictures. The scene went on until the doctor got out of the car and stuck the false limbs on to the body of the cripped actor.

Then the photographer once more ceased to work his machine, and the working-man actor who had first pretended to fall asleep in the middle of the road took the place of the cripple. By setting the camera going again, and recording his actions after his supposed recovery from the accident, the strange scene was brought to a conclusion.



HOW A MAN IS PHOTOGRAPHED CLIMBING UP A HOUSE

By choosing an actor who resembled the real cripple in size, and by getting him to "make up" his face so that he could not be distinguished from the other man, an effect of extraordinary illusion was produced on all the hundreds of thousands of people who flock to the picture palaces. It was a silly and senseless performance, an abuse of the wonderful power of the cinematograph, and it is a pity that the men who control the picture palaces should have no better ideas than to use poor cripples in this way and make up foolish scenes. But it is extraordinary and clever, all the same, and very few people were able to guess how it was all done.

The trick of stopping the camera in the middle of a scene, and then introducing a new arrangement of the figures, brings about many of the magic effects obtained in moving pictures. It may have taken half an hour or more to make the actual change in the performance, but as the scene is shown in the cinematograph theatre there is only the ordinary interval of a small part of a second. So in the moving pictures an old witch changes into a beautiful young lady in the twinkling of an eye, though in the performance the camera had to be stopped while the actress who was taking the part of a witch skipped away and changed places with a prettily dressed girl. In the same way, the camera is stopped to get a series of moving pictures showing a lovely mermaid swimming in the depths of the sea, with fishes playing around her, and some divers descending through the water to her wonderful home beneath the waves.

This effect is produced by two sets of photographs. In one set a great aquarium tank, full of real fishes, is recorded by the operator, and some divers are engaged to descend into the tank while the photographs are being taken. The divers are photographed in quick succession on a narrow ribbon of film, perhaps two hundred feet long.

THE FAIRY WALKS ACROSS THE TABLE

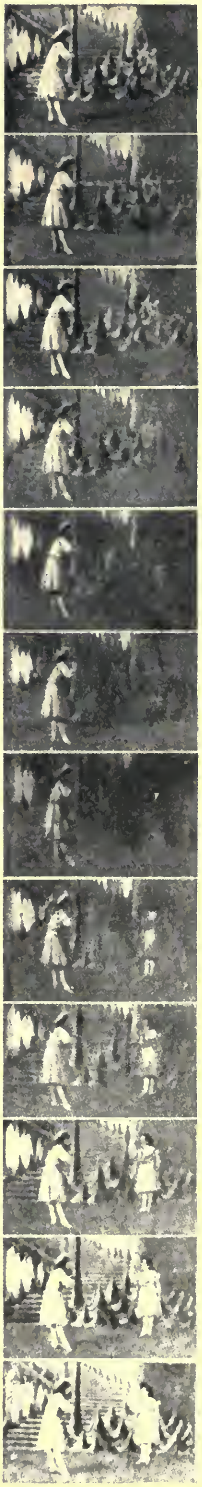
THE FAIRY DANCES IN THE BOTTLE

THE FAIRY BUILDS A BONFIRE OF MATCHES

The film unrolls and passes before the lens of the camera, and receives the rapid images, and then rolls up in another part of the machine. Now, supposing the scene in the aquarium tank has been recorded on one of these long, thin films. Then comes the problem of getting the living mermaid into the same set of pictures. For this, the operator takes his machine up a ladder and along a scaffold just beneath the ceiling, and there he fixes it pointing downwards towards the floor, where a cloth is laid painted with sea-plants to represent the bed of the ocean. Just above the sea-plants an actress, dressed as a mermaid, lies on the cloth and moves herself as if she were swimming in the ocean depths. Now and then, at a word from the stage-manager, she gives a look of pretended fright, as though she sees a diver coming close to her. As she does this, the camera is set to work again, and the same film on which the fishes and divers have been photographed is re-passed before the lens while the actress is pretending to swim on the painted cloth on the floor. The result is that a long series of new pictures of all her movements and glances is impressed on the film, so as to combine with the former pictures of the water and fishes and divers. And so, if all her actions are carefully timed and arranged, the "mermaid" appears, when the film is developed, to be swimming about in the sea-water, with finny creatures circling around her, and men in diving dress staring at her in amazement through the goggles of their helmets.

This method of printing two scenes on one film, and combining them into a single set of living pictures, is called "double printing." Many weird and magical and beautiful effects can be obtained by this trick. One of the first fairy tales shown in moving pictures was arranged by the method of double printing. It began with a midnight meeting on the battlements of a castle, between a gallant knight and his charming sweetheart. A ghost appeared on the castle wall. The brave knight rushed at the spectre and tried to seize it, but it melted from his grasp. Then over the dark sky came a witch, furiously riding upon a broomstick. The undaunted knight attacked her in turn, and drove her away. But the next strange visitor was too powerful for him. A giant of tremendous size raised his head and shoulders over the battlements, seized the beautiful girl, and carried her away through the sky, leaving the knight in the depths of despair. A good fairy, however, quickly came to his help, and gave him a flaming sword, and by means of this magic weapon the knight at last succeeded in rescuing his lady-love from the witch and the giant.

The story pleased and puzzled grown-up persons as well as children, for it could be clearly seen that all the figures were those of living people; even the tremendous giant was an actual human being. So everybody in the audience wondered how it was done, but it was some time before the secret was revealed. The trick effects were produced almost entirely by double printing. First of all the scene between the knight and his lady-love was acted on the stage of a theatre, with proper scenery, and photographed. Then the actor and actress left the stage, and a very robust-looking ghost walked on while the camera was stopped. When the ghost had got into his proper position, the lens of the camera was opened only just a little bit, letting in a very little light. So a very shadowy, indistinct photograph of the spectre was obtained. The ghost then went away, and the knight came back with the lady, and was photographed in the act of pretending to see the ghost and grasping at the spot where it had been. Then the two sets of photographs were combined into one, and the figure of the ghost was so shadowy that the stones of the castle wall could be clearly seen through his only partly photographed body.

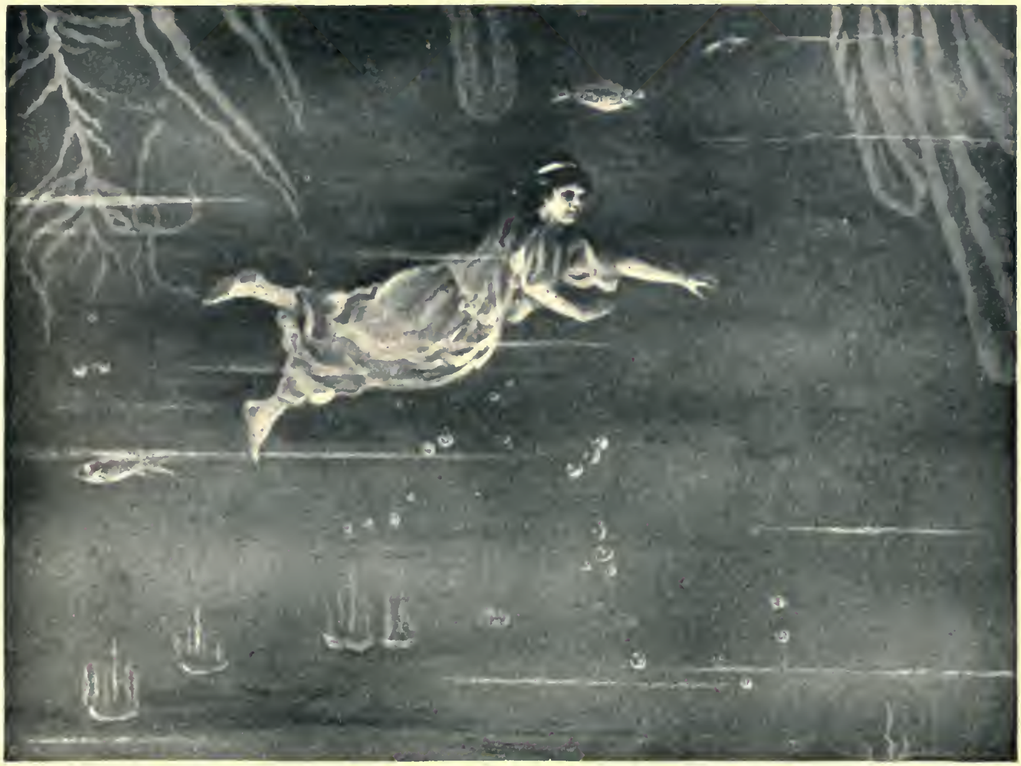


THE FAIRY COMES while the camera is partly closed.

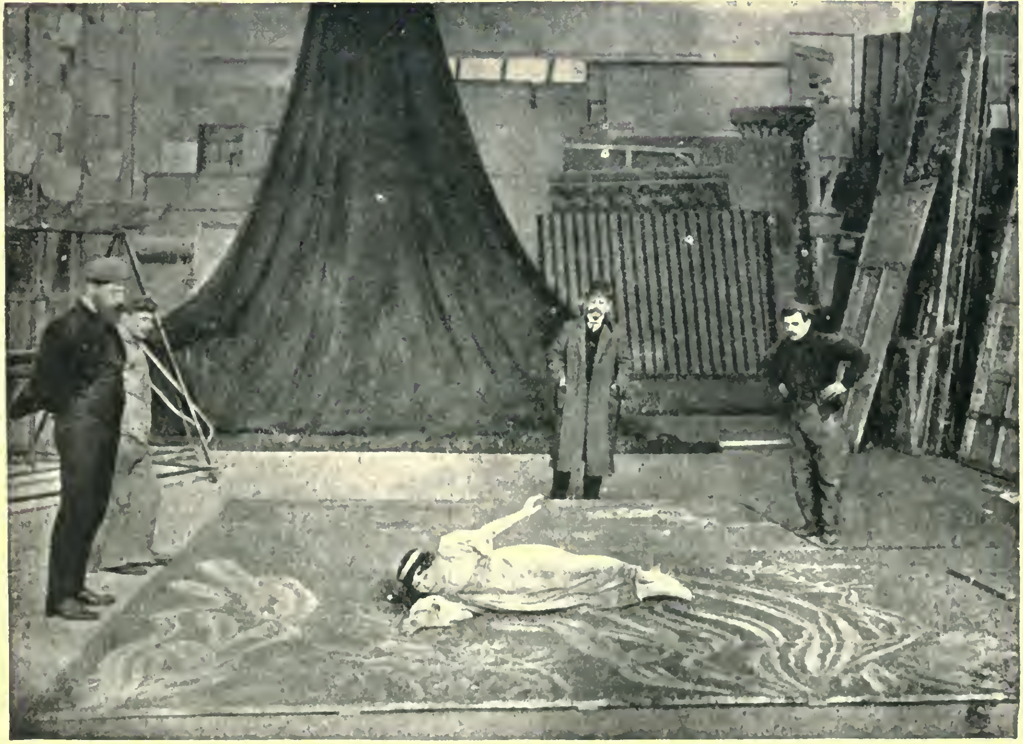
Throughout the performance the knight and the lady never saw the ghost and the witch and the giant at all. They merely went through their parts, pretending that they were being menaced and attacked, and keeping their proper places on the stage, so that the other figures could be fitted into the scene afterwards. The giant was an ordinary actor, made to appear of tremendous size by a very simple method, merely standing closer to the camera than the others. The result was that he seemed so big in the photograph that his head and shoulders filled all the sky above the castle wall. When he put his hand over the wall in the act of capturing the lady, he really took up a little doll dressed like the lady.

A different and more ingenious trick with the camera was used in getting a series of photographs of the witch riding through the sky on a broomstick. It could have been done by suspending the witch on wires hanging from the ceiling, and then getting some men on a high platform, out of sight, to move her by means of the wires through the sky. This, however, would have been very costly to arrange, and somewhat dangerous for the witch, for some of the wires might have broken under her weight. As a matter of fact, it was all done by swinging the camera round as the pictures were rapidly taken. The witch merely sat on her broomstick against a black cloth with a moon painted on it. She never moved —the lens of the camera did all the work. The ribbon of film behind the lens was made to run in a straight and true direction, while the lens itself was moved so as to print images of the witch in different positions on a series of photographs previously taken. Thus there were obtained some pictures of the witch apparently rising in the sky on her broomstick, and then sweeping down to the top of the castle wall. The movement was there, but it was the film that moved in front of the witch, and not the witch in front of the film.

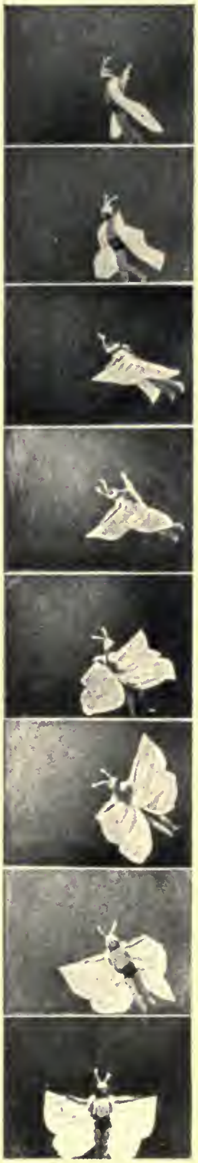
This curious trick of getting pictures of strange movements that



THE PICTURES ON THE SCREEN SHOW A WOMAN MOVING ABOUT IN THE WATER



IN REALITY THE WOMAN MOVES ABOUT ON DRY LAND, BEING PHOTOGRAPHED FROM ABOVE never take place is often practised in cinematography; it is more satisfactory than the use of invisible wires. But though wires were not used in helping the witch to perform her strange journey through the sky, they are often employed in magic scenes. When all the furniture of a room begins to hop and move about by enchantment, to the pretended terror of the actors in the scene, there are always some stage hands, above the stage, hard at work pulling the wires that make the chairs and tables perform their antics.



THE HUMAN BUTTERFLY

She stands still while the camera revolves round her, giving the appearance of flying.

The most amusing example of the wire-worked scene was the story of "The Magnetic Man," which was very popular some time ago. The magnetic man was afraid of being attacked and robbed when he went to Paris, so he put a coat of iron armour beneath his waistcoat, and started out to see the sights. Unfortunately, he passed very close to a powerful electrical machine charged with magnetic force, and the consequence was that his hidden coat of armour suddenly became full of intense magnetic force. So when he walked by a hardware shop the iron vessels nearest to him broke away from their hooks, jumped through the air, and stuck to his clothes. Away he scampered, with all the articles clinging to him; and, to his horror, as he passed over a manhole cover of iron in the middle of the pavement, the cover rose up on edge and bowled along the street in pursuit of him. Then, apparently, his magnetic force continued to increase, for as he came too close to a lamp-post the great strong pillar snapped in two and fell down upon his shoulders.

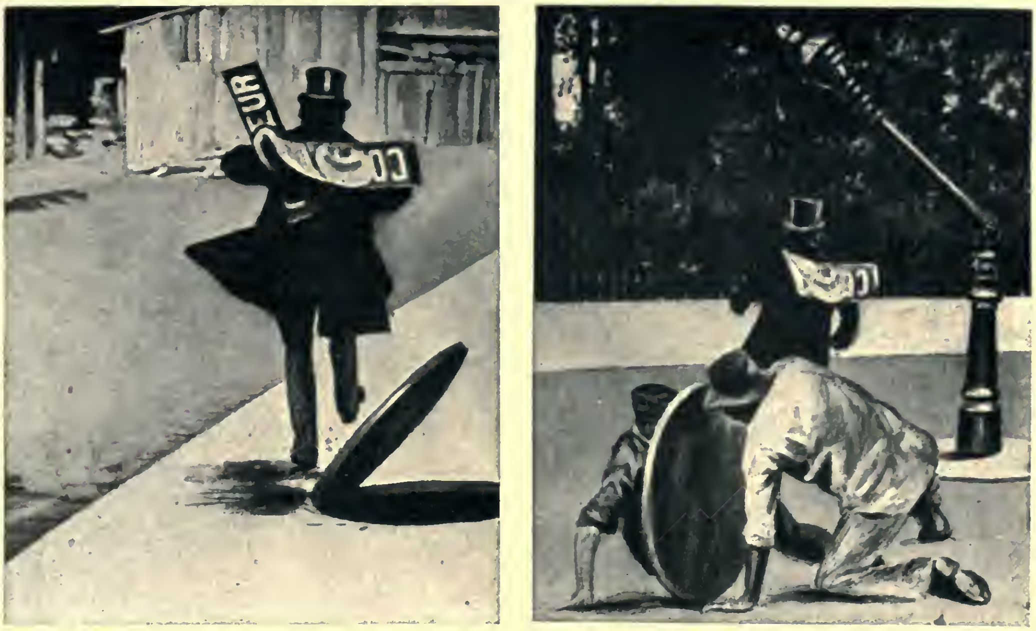
The whole of this curious scene was arranged by means of wires. The hardware shop was actually a hardware shop: but the owner was paid a good price to hang some of his articles up very lightly, and attach them by means of wires to posts fixed in the curbstones. The actor representing the magnetic man intentionally swung against all the wires, jangling everything outside the shop, while by a hidden movement of his hands he tugged at some of the wires, and pulled towards him the articles to which they were fixed and hooked them on his clothes. Naturally, the camera was stopped from working while the iron mugs and plates were being attached firmly to his coat. The supposed manhole cover of iron was really made of light wood. A stage hand held the end of the wire as the actor passed, and he grasped it in the middle and raised the cover up. The lamp-post was also made of wood, and hinged half-way up to permit the upper part being pulled over when the magnetic man struck against the wire stretching from the lamp-post to the railings.

So we see that some of the strangest and most entertaining of magic moving pictures are produced by very simple means. Yet when the scene takes place in the actual streets of some well-known city a great deal of preparation is necessary, and a good many men are needed to see that everything goes off properly, and that the actor and the man who takes the pictures are not hindered by passers-by. To avoid crowds collecting and introducing themselves into the pictures when they are not wanted, the work is often done very early in the morning, and a large band of men are engaged to act the parts of the ordinary people who come in the picture, so as to make it appear a usual, everyday scene.

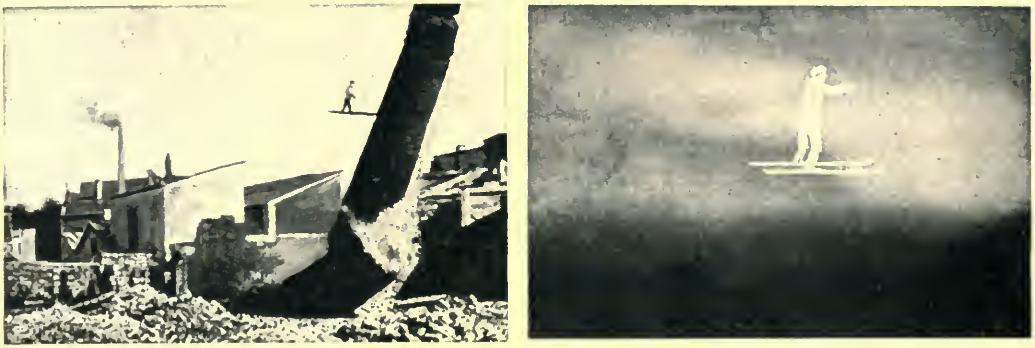
The strangest effects, however, are usually produced on a specially fitted stage. Houses that fall to bits and catch alight, and send up clouds of smoke, are made out of hinged pieces of wood. And as the hinges give way, and the structure tumbles down, a band of stage hands, just out of reach of the camera that is recording the scene, pitch a lot of rubbish into the house, and turn a pipe of hot steam beneath the stage to produce the appearance of smoke.

A special apparatus is used in bringing the tiny figures of fairies into a picture of ordinary life. For instance, in the story of "Princess Nicotine," an actor sits at a table in the middle of the stage and begins to smoke a pipe. Some distance behind him, at the back of the stage, is a large mirror. By means of this

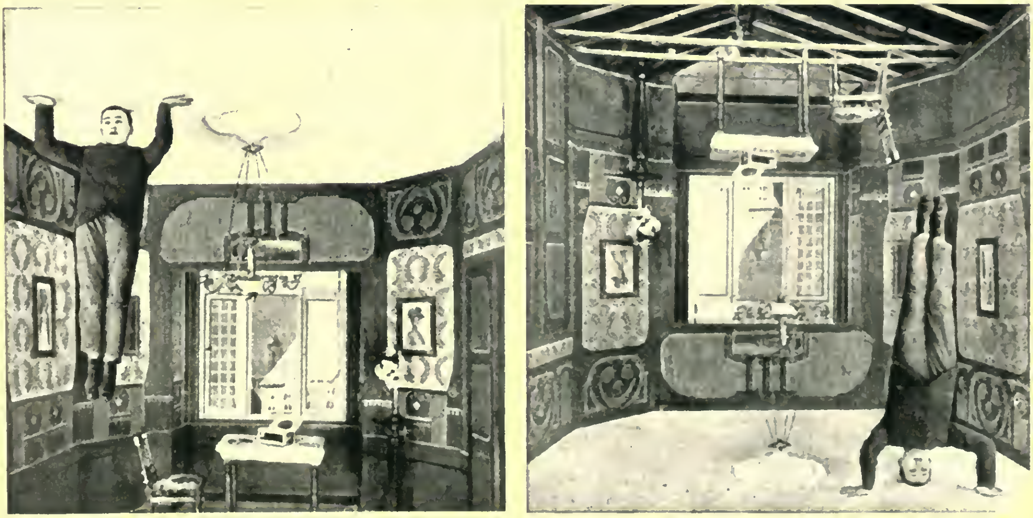
HOW THE MOVING PICTURE TRICKS ARE DONE



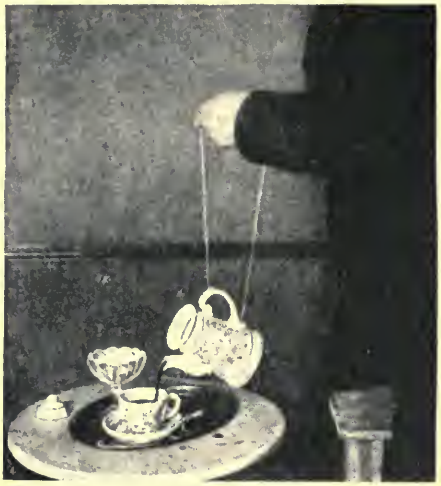
THE MAGNETIC MAN REALLY DRAWS SHOP-SIGNS, CELLAR-LIDS, AND LAMP-POSTS TOWARDS HIM BY THIN WIRES



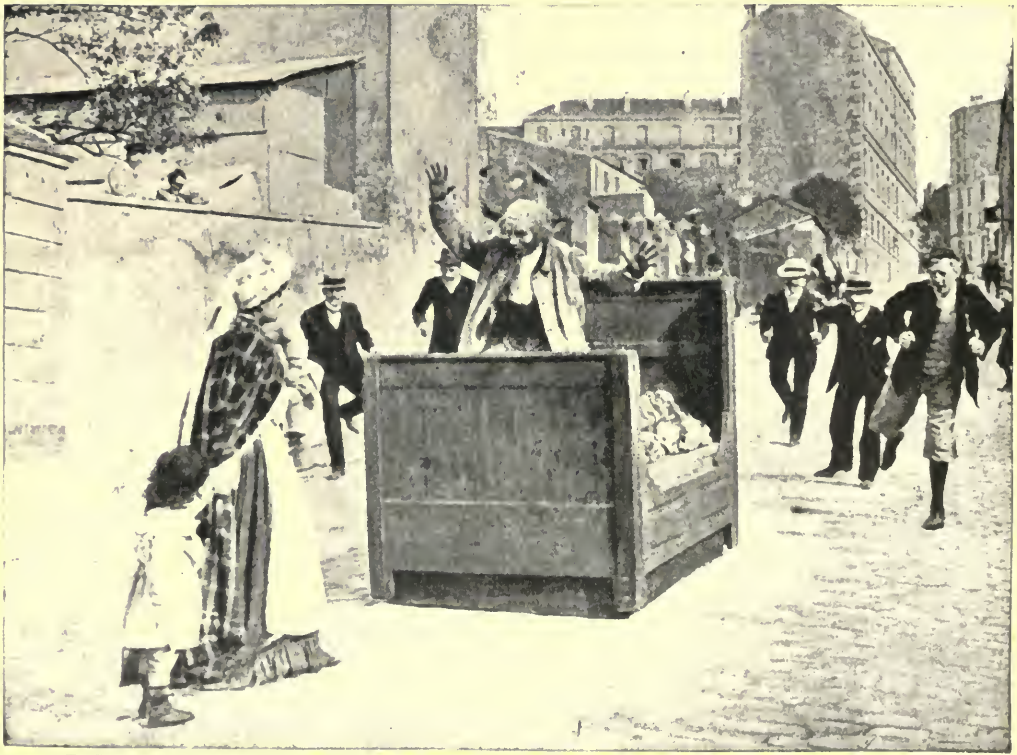
THE SKI-RUNNER IS PHOTOGRAPHED ON A FILM THAT ALREADY HAS THE CHIMNEY AND CLOUDS



THE WALKER ON THE CEILING SEEN HERE IS PHOTOGRAPHED WALKING ON THE FLOOR, AS SEEN HERE mirror it is easy to make a fairy appear from the bowl of the pipe that the man lays down on the table; for just beside the camera, at some distance in front of the stage, is placed a great bowl of wood with a long stem, which is painted to look like a pipe. The bowl is often six feet high, and the smoke that comes from it is produced by opening a steam-pipe in the top of the bowl. An actress dressed as a fairy jumps inside this big bowl, and then the operator of the camera directs the lens of his machine to the mirror far away at the back of the stage. In this mirror appears, on a tiny scale, the reflection of the big artificial pipe, with the steam curling from it; and when the actress jumps out from the bowl she appears a very small creature in the mirror. Thus the curious and pretty effect of a tiny tobacco fairy living in the bowl of the pipe is obtained.


THE SECRET OF THE TEAPOT THAT POURS OUT ITS OWN TEA

Practically all the trick effects that amuse and puzzle us in a picture palace are managed by unseen wires, by printing two sets of photographs on the same film, or by mirrors and other stage properties. Then, by stopping the camera while some transformation scene is being prepared, all sorts of magical disappearances and visitations and changes are easily worked. The cinematograph is a marvellous invention, and can be put to splendid uses; but we must never be deceived by its trick pictures, which, however quaint and laughable they may be, are unnatural absurdities. By far the best moving pictures are those of actual everyday happenings and scenes in natural history. The trick picture is becoming so common that all the tricks will soon be known, and then, perhaps, the cinematograph will be put to its better and more useful purpose.


THE BED THAT RUNS UP THE STREET—IT IS REALLY BEING PUSHED FROM BEHIND

FOREST RESERVES

HOW THE TIMBER CROP IS PRESERVED FROM WASTE

A CROP OF WOOD MAY BE GROWN, LIKE ANY OTHER

There was a time when the greater part of the solid surface of the earth was covered with forests. In those days, before the earliest records of history, men were able to live on the bounties of nature. They slept in trees or in caves and when they were hungry they killed wild animals or picked the fruits from the plants and trees that grew in such profusion about them. But as their numbers increased these easy conditions of living changed. They were compelled to increase their food supply by domesticating animals. Then the food plants became scarcer and they set about cultivating them.

To make more room for food plants, which required much sunlight, they cleared away trees. The open clearing was probably the first sign of real civilisation, for it indicated that men had begun to work. But even more destructive to the forests were the domesticated herds, for as they browsed among the trees they devoured the sprouting seedlings or trampled them down. Consequently when the big trees died or were used for fuel the country became bare, which made it even more suitable for pasturage.

THE IMPORTANCE OF WOOD INCREASES

Yet the forest never ceased being one of the chief sources of supply of man's needs. First of all it was needed as fuel. Then, as civilisation advanced, it was used for the building of houses. Nor has its importance decreased in modern times; to-day more wood is used for each individual of the population than ever before.

England was the first country in which the scarcity of timber began to be felt. But as the English communities were generally situated on the water, they were able to obtain additional supplies from distant places. In the interior countries of Europe the problem of obtaining further supplies was more difficult. Over a hundred years ago, even before the French Revolution, the interior districts of Germany, Austria and France began experiencing a pressing scarcity of wood.

At this time it was not that the forests were really disappearing. As yet a comparatively small proportion of them had been destroyed. The difficulty was their distance from the centres of population. There was still timber in plenty, but it was far away and could only be transported to those communities actually living on the water.

ATTEMPTS TO REDUCE THE AMOUNT OF WOOD USED

It began to dawn upon the people of the interior countries that they had been needlessly wasteful. So laws were passed regulating the use of wood. In Germany the sizes of houses were limited. One law, in Austria, compelled the people to bury their dead in canvas bags, that wood might not be wasted in the making of coffins. No wood could be shipped as fuel from one district to another and the bakers of one town were even forbidden to bake bread for their neighbours of another town unless their customers brought their own fuel with them.

It was then, especially in Germany, that the idea of forest preservation occurred. The government commissioned experts to study the problem. It occurred to them that if trees could be grown especially to supply apples, there was no reason why they should not be grown to supply wood.

Unfortunately it takes a tree such a long period to become large enough to be of value for its timber that private individuals were not disposed to take up timber culture as a business. A man would have to wait almost a lifetime for the first profits on his invested capital to come in. For this reason the state was compelled to undertake this new enterprise. Therefore silviculture, the raising of wood, has been almost entirely a state business. Germany was the first to establish schools in which experts in this profession could be trained, as the agricultural schools trained them to raise cabbages and potatoes.

THE RAILROADS INCREASE THE DESTRUCTION OF THE FORESTS

It was the introduction of steam railways that brought a big, though tempo-

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rary, relief to what had already become a serious timber famine. The railways, passing through the distant forests on their way to other cities, loaded the timber on freight cars and brought them over distances too great for wagon transportation. Once more the people in the inland communities could have all the timber they needed at cheaper prices than they had ever had it before.

Fortunately there were men in some of the European countries who realised that the relief brought by the railroads was only temporary, that it would be only a question of years and again there would be a scarcity. The railroads, indeed, added a new danger to the forests. As the locomotives pounded along those stretches of their routes laid through the heavy timber, sparks would fly from their stacks and set fire to the underbrush in the dry seasons. As a result whole districts would lose much of their forest growth after a few days of conflagration.

In Germany, Austria and France the government reservation of forests continued. Each year larger and larger sections were set aside on which timber cutting was forbidden, except in limited quantities, under the supervision of the government's special experts. And as the mature trees were cut down seedlings were planted to take their places.

Other countries, however, were not so provident. In Spain and Italy the scarcity of timber is now being felt very sorely. Being obliged to import it from those countries which have regulated the growth of forests, the Italians and Spaniards must pay heavy prices. But the destruction of their forests has brought them other bad results as well, evils which we have had to suffer in this country also, because of our wastefulness.

HOW FORESTS HELP THE FARMERS

Through studying conditions in those districts where the forests were destroyed the scientists have been able to show that trees have other values besides serving the population with timber. The effect on climate is important. The unusual and growing violence of the floods of late years in certain sections, notably in our Ohio Valley, has been attributed to the destruction of the forests in the hills and mountains. When you spill a glass of milk on the table, your first instinct is to throw a napkin or a towel over it, to save the liquid from spreading over on the floor. The napkin absorbs the moisture and retains it.

This is just what the forests do in the mountains and hills when the heavy rains begin. First of all the canopies of leaves catch and hold a vast quantity of water. Next the water drops down on the thick layer of leaves on the forest floor, which acts as a mop, retaining vast quantities of moisture. After that the roots of the trees, spreading down and through the soil, drink in a further portion, each root laying in its storage of water with which to supply the leaves above during the dry period. It is only after these various reservoirs have been saturated that the water begins running down hill toward the valleys below. Then, long after the rainy season has come to a close, the water in the forest carpet seeps down into the soil and supplies the springs, which burst out on the hillsides and gradually grow into larger streams.

So well known is this action of the trees on our water supply that nearly all cities now devote much care to the cultivation of the woods on those hills serving as the watersheds to the city water works. The slopes about Croton Lake, which supplies New York with its water, have been cleared of all houses and the trees are cared for with as much care as they are in the city's parks.

FORESTS PREVENT SOIL DESTRUCTION

Soil erosion is another evil that follows forest destruction. Where the hills have been bared, the heavy rains descend and wash down huge quantities of the loose soil into the valleys below. Big fissures and gorges are ripped into the sides of the slopes, sometimes followed by destructive landslides. By maintaining forests the soil, even on the steep slopes, will remain in place. The roots grasp and hold together the particles of soil, just as the straw that is sometimes put into bricks holds them together. Thus the whole mountainside may be matted together by the roots of the trees. In the Alps and Pyrenees, where landslides and avalanches have been a constant danger, the loose rocks are cemented to the mountainside and wattlework of sticks woven between stakes is made, to hold the soil in place until the trees have a chance to grow.

Trees also serve to equalise the humidity of the regions in which they grow, especially in inland districts. After the rains are over the leaves, drawing up the moisture from the roots, throw it off into the atmosphere. Countries without trees, such as certain parts of Arizona and Colorado, are notably dry. It has even been said by some scientists that the destruction of the forests in Spain has caused the downfall of that country. The dry, hot climate that has resulted has so sapped the energy of the Spaniards that their former activity, which made them one of the foremost nations in the middle ages, has degenerated into almost universal indolence.

THE UNITED STATES AND THE FORESTS

Aside from Spain, Italy, Greece and a few other European countries, the United States has been the most backward, until quite recently, in the cultivation of forest reserves. This is not due to inferior intelligence, but to the belief that was held here, until only a short time ago, that the vast forests were inexhaustible. And certainly it did not seem, fifty years ago, that the nation would ever be troubled with a scarcity of timber.

But the railroads have brought about a situation here similar to that in Europe. First of all settlers scattered all over the wide country and began clearing farms. With them they brought fire. Hitherto forest fires had been quite rare. Lightning was almost the only cause of such fires. Next came the cattle ranches, on such a big scale as had never been known before, and the cows and sheep began destroying the seedlings on the ranges, just as had happened in prehistoric times. With the heavy immigration great cities sprang up, demanding timber for their all-wooden houses. All through the forests resounded the whining hum of sawmills. Fifty years ago there were about thirty million people in the country: to-day there are nearly one hundred million. All must be housed. Each man, woman and child of the population uses up each year a block of wood over six feet square. All the great forests are growing each year only a fourth as much as is being used and wasted.

It was only twenty-five years ago that the United States government felt impelled to take the same action taken by the German government over a hundred years ago. Congress passed an act giving the President power to set aside tracts of forest land from time to time. This has been done ever since until now there are about two hundred million acres reserved, mostly west of the Rocky Mountains and in the mountains of the arid regions.

NATIONAL FORESTS IN THE EAST

Although so much had been done to protect the Western forests from fire and needless waste, nearly twenty years of agitation were required to rouse the government to the danger of total destruction of the forests in the Southern Appalachians and the White Mountains. There had been no definite reform plan offered until 1899, when there was founded an association in Asheville, N. C., for the establishing of a National Park in the Appalachians. Through their efforts an investigation was made the following year by Secretary James Wilson, and in his report, presented to Congress, he advocated the setting aside of a National Forest in the East for three reasons: to preserve the timber, to regulate the supply of water and to afford recreation grounds for the people. Many bills were brought before Congress, but it is not until 1914, nearly fifteen years after the first organised movement, that President Taft signed the Weeks Bill, which appropriated $10,000,000 for the purchase of lands in the Southern Appalachians and the White Mountains. This bill was passed by Congress, not for the reasons of the Park Association, not for the purposes advocated by Secretary Wilson, but to protect the headwaters of navigable rivers. Since then tracts in New England and in North Carolina have been purchased.

The forest reserves in the United States differ from those in Germany very materially. In Germany a forest reservation is really a plantation operated by the state: the trees are grown from seeds in nurseries, then they are set out in regular rows, like orchards. Then their growth is attended to with as much care as the farmer devotes to his tomatoes or cucumber vines. Only when a tree is mature, when it has acquired a certain size, is it cut and the lumber sold.

HOW FORESTS ARE PRESERVED

In this country forestry is still in a primitive stage. At first, when the reserves were set aside by the President, the settlers were simply forbidden to cut any wood at all. Rangers, sometimes soldiers, were set to guard the forests. There was hardly a man in the country who understood scientific forestry. But the demand of the government for experts caused young men to go abroad to study in the foreign schools and to-day we have men who understand silviculture quite as well as the Europeans. The forest reserves are now under the care of a special bureau in the Department of Agriculture. The field force consists of a protective body of guards and rangers.

The first duty of the rangers is to protect the forests against fires. Each has assigned to him a district which he must watch or patrol. At all the high points men are stationed on lookout, to report any indication of smoke to headquarters at once. For this purpose telephone lines stretch from all the lookouts to headquarters.

A LOOKOUT ON A MOUNTAIN TOP

The moment a lookout reports smoke a general alarm is sounded, just as is done in a great city, and all available men hasten to the point at which the fire is reported. Water, of course, plays no part in this sort of fire fighting. In the better kept forests wide swaths are cut through the timber, across which the flames are not likely to leap. Another means of combating forest fires is the back fire. The men go to a point some distance ahead, toward which the wind is driving the fire, and there they start a fire backward, which shall head off the main conflagration.

FIRE THE GREAT ENEMY OF FORESTS

Each year the Forest Service men extinguish something like three thousand fires, most of them before they can damage more than a few hundred acres. Sometimes, however, when the weather is unusually dry and strong winds are blowing a fire will gain such headway as to threaten, not only vast stretches of forest, but human life as well. In 1910 the season was especially bad and nearly a hundred men lost their lives in fighting forest fires on the national reserves. In one case the chief ranger saved his men only by taking refuge in the mouth of a mine tunnel and hanging a wet blanket over the entrance.

Next to the protection of his district from fire the ranger must attend to the cutting of the mature timber. He marks those trees that are to be felled, supervises their cutting, so that there shall be no waste and has them placed on the market for sale. No small part of his qualifications is business ability, for the government looks to him to obtain the best possible prices for its timber.

Another important duty of the Forest Service is the protection of the trees against insect pests. There are three classes of insects in the forests: those that are beneficial, those that are neutral or harmless, and those that are obnoxious,

FIGHTING FIRE IN A MONTANA FOREST

Fire is out in the forest, as the smoky atmosphere shows. Instead of fighting it directly, which would be difficult, the men are here clearing the ground, in the hope that when the fire reaches the bare ground it will not be able to cross. In a strong wind, however, fire often leaps many feet across such an open space.

A FIRE GUARD IN CALIFORNIA, PREPARED IN ADVANCE

Years ago a narrow trail led through these woods. The forest service has cleared a space sixty feet wide, stretching for miles over the hills, and the brush has been burned. If fire should break out on either side, it could not cross the fire guard, unless the wind blew with force enough to carry the sparks across.

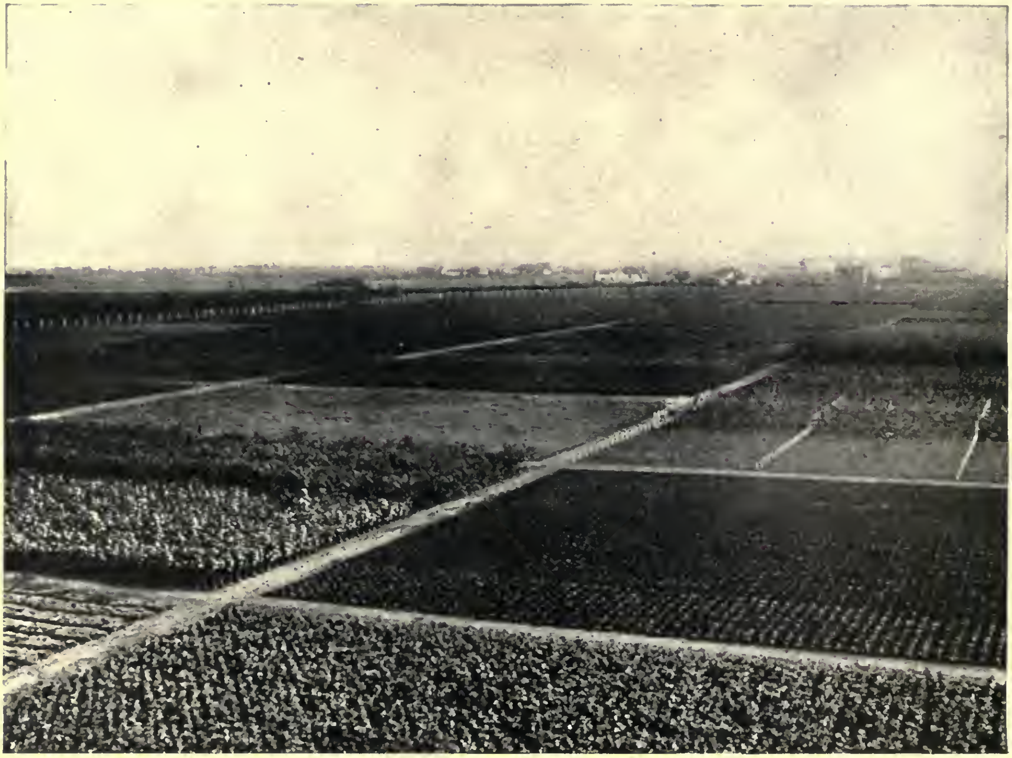
that harm the trees. Among these latter are two kinds: the borers, which bore into the young wood; and the defoliators, which eat the leaves and young buds.

HOW INSECT ENEMIES ARE DESTROYED

The first measures taken against the obnoxious insects are to encourage their enemies. Bats, toads, snakes, lizards, birds and certain species of insects are encouraged, even propagated. If the forest is infected by obnoxious insects in spots, the trees that have been attacked are destroyed, usually by fire. The forests are always more subject to insect attacks after fires, for then many of the trees have been injured and have lost their vitality. A healthy tree has such an abundance of sap that it drowns the boring insects that penetrate within its bark.

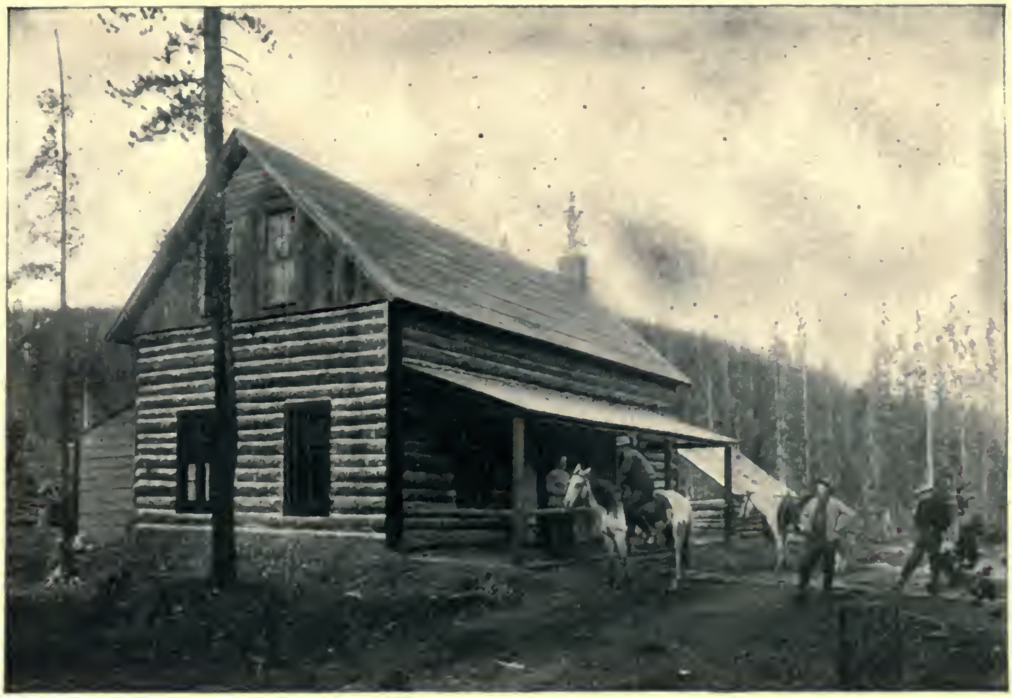
Among the men who make forestry a profession there are tree doctors; those who specialise in the diseases of trees and their treatment. Forest trees are often seriously affected by fungus diseases. One of the most common is what is called "damping off," a fungus growth which causes the seedlings to rot close to the ground. The causes are damp soil, high temperature and a humid atmosphere. When the forester finds a district so infected he carts in wagon loads of sand and has it sprinkled over the forest floor.

Obnoxious weeds, too, must be removed in a properly cared for forest, just as in a kitchen garden. These create an undergrowth and sap up the strength of the soil about the roots of the trees. In Europe in the planted forests, leguminous plants, such as peas and beans, are planted around the bases of the trees to introduce nitrogen from the air into the soil. It must not be supposed that all kinds of trees are encouraged in a forest reserve, simply because they are trees. Some trees are much more valuable for timber than others, though usually the valuable timber takes longer to grow.



THE BEGINNING OF FUTURE FORESTS

This picture resembles an ordinary market garden. It is, however, a tree-nursery. Here thousands of trees of all kinds are grown from seeds, and carefully tended until they are ready to be transplanted. It is difficult to realise that these tiny plants may one day be gigantic oaks or firs with wide-spreading branches.



A RANGER'S LODGE IN THE FOREST

Here we see a cabin in the Arapahoe National Forest, in Colorado, which is occupied by forest rangers. The cabin is of logs with the spaces between filled with clay or mortar. Such a cabin may be very comfortable, though in the winter, life must be exceedingly lonely. The log stable is in the background.

TELEPHONE WIRES IN THE FOREST

In order that the forest rangers may communicate with one another, telephone wires are often strung on the trees. When a ranger discovers a fire, he can call other rangers, give the alarm and summon help at once, often preventing great damage. Any suspicious circumstance can be reported to headquarters and instructions asked. Then too the telephone relieves the loneliness of the ranger's life.

DIFFERENT CLASSES OF TREES

Broadly speaking, trees may be divided into two distinct families. These are the conifers and the broad-leaf trees. The conifers are more frequently found in colder climates; they include the pine, spruce, fir, the California redwood and dozens of other varieties. The broad-leaf species include the oak, beech, chestnut, walnut and many others. Usually they lose their leaves in the autumn when growing in cold climates. Classed with these are the hardwoods of the tropical countries, such as the mahogany, camphor wood, etc.

Usually the broad-leaf trees, whose timber is hard and more valuable and is used for more important purposes, take longer to grow. Oak is not worth much under one hundred years of age. On the other hand poplars are rapid growers and may be utilised within twenty years of planting. Spruce, too, may be planted and cut into timber by the same man. The gum tree, or eucalyptus, of Australia, grows especially fast and attains a tremendous height, sometimes two hundred feet. In California several private companies have attempted to grow this tree for business profit.

PURE AND MIXED FORESTS

There are two kinds of forest reserves; the pure and the mixed. In the pure forests only one kind of timber is grown. This system is especially practised in Germany. But there are experts who believe it more profitable to cultivate mixed forests, where two or more varieties are planted. One of their reasons is that when a pure forest is attacked by insect pests, all the trees are destroyed, for these pests usually have their favourite trees. In a mixed forest only one species of trees will be destroyed. Then there is another reason. Some trees have much deeper roots than others. By planting the two kinds in one reserve the trees do not exhaust the soil so much, for while one draws its nourishment from an upper layer of soil the other drains only the soil lower down.

But even after choosing the kinds of trees that are to be grown, it rests a great deal with the head forester whether the quality of the timber will be good or poor. Wood with knots is never desirable. That they may not be formed the lower parts of the trunks are pruned and dead branches are removed. A dead branch especially forms loose knots in boards and planks.

The fewer the branches the better will be the quality of the wood. But it is preferable that trees are grown in such a way that they will naturally shed their lower limbs. Trees grown in the open retain their limbs close down to the ground. By growing the trees close enough together so that their foliage creates a canopy overhead, the lack of light below discourages the growth of limbs.

THE FOLIAGE AND THE TIMBER

The most important part of a tree is its crown: the foliage near the top. The crown regulates the production of the wood. The smaller the crown the less wood is produced. It grows slowly, however, and the lower limbs are shed while small. The wood thus produced is almost without a blemish. By regulating the size of the crown, the growth of the wood is regulated. Time is sacrificed for quality.

It is in this way that all the timber used in Germany is grown. Every acre of the government forests, comprising about one-third of all the forests, yields a net profit to the treasury of about $2.50 a year. Some bring as high a profit as $12.50 a year. Aside from that employment is afforded hundreds of thousands of men, forming a healthy, stalwart element of the population. Even some of the cities are engaged in this form of enterprise, to such advantage that the taxes of the citizens are considerably lightened and, in some cases, done away with altogether. So successful has the state been in its forestry business that now private individuals, content with a slow but sure income from their money, are embarking in the same form of business.

With the progress that the United States Forest Service has made of late years there is no doubt that we shall one day harmonise the growth of our forests with the demands of the people. The use will be decreased and the growth increased. Each individual of our population now consumes four times as much timber as each individual of some foreign countries.

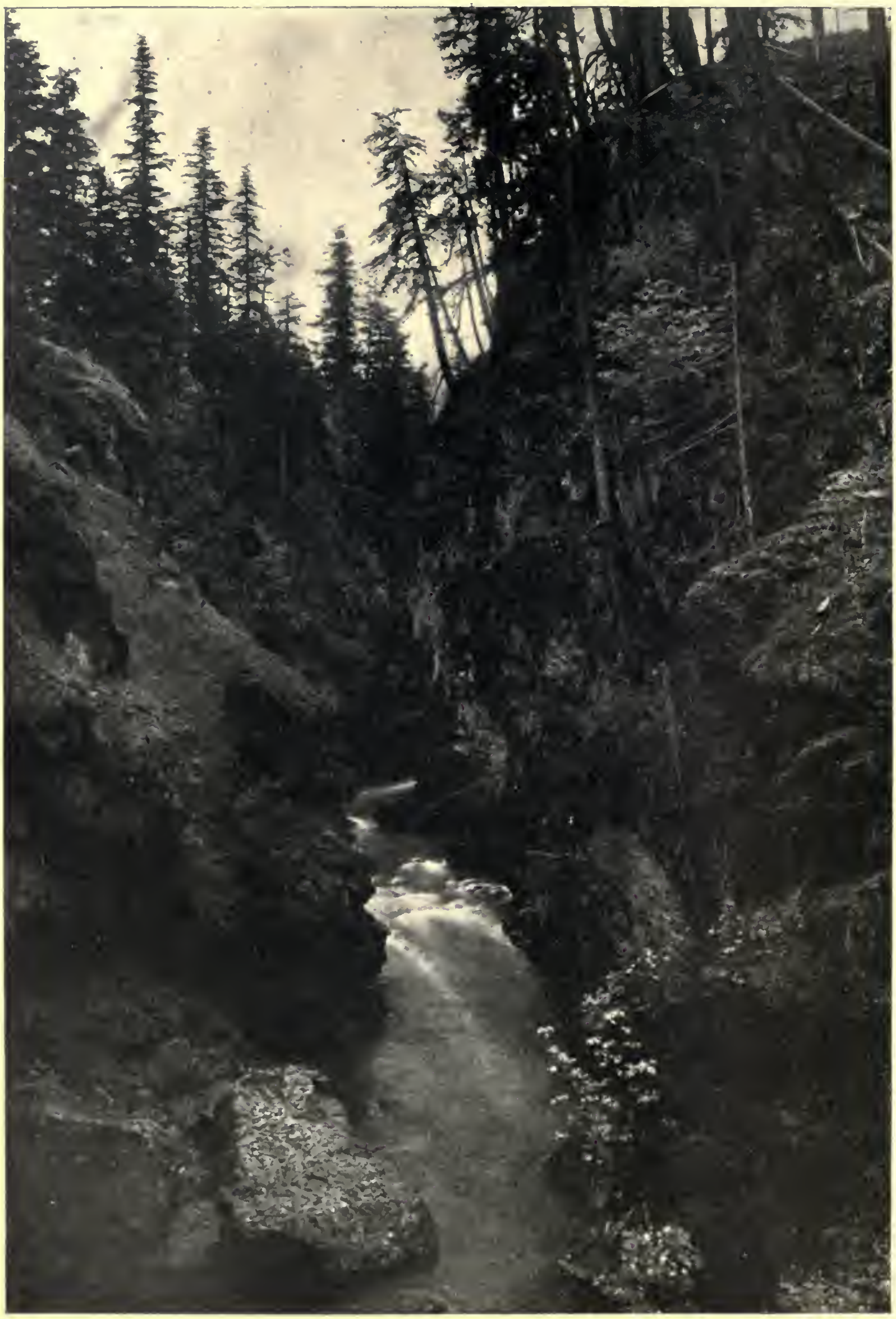
SCIENTIFIC LUMBERING IN COLORADO

The old way of cutting trees was to cut those wanted and leave the brush, which often caught fire and destroyed all the remaining trees. Here only trees of the desired size have been cut and the brush is being collected in small piles. It will later be burned carefully to prevent the danger of forest fires in the future.

A FOREST BLASTED BY FIRE

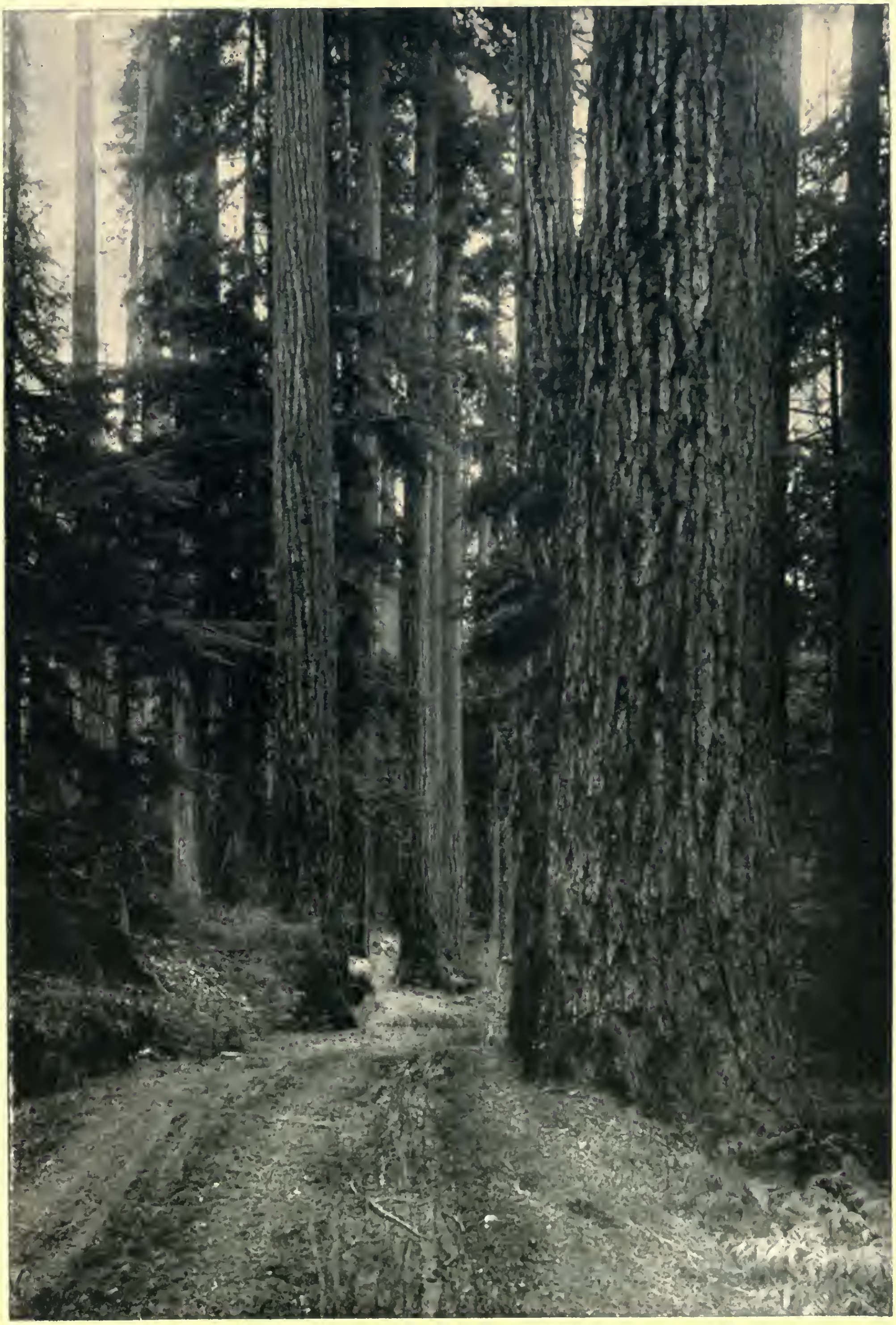
Here the fire has burned off the underbrush and has been hot enough to kill the standing timber. The vegetable matter in the soil has been burned up, and even if these dead trees are cut down and others planted, it will be many, many years before the new growth reaches the present size of the old, which of course would have kept on growing. Millions of dollars have been lost by forest fires.

THE HEADWATERS OF A WESTERN RIVER



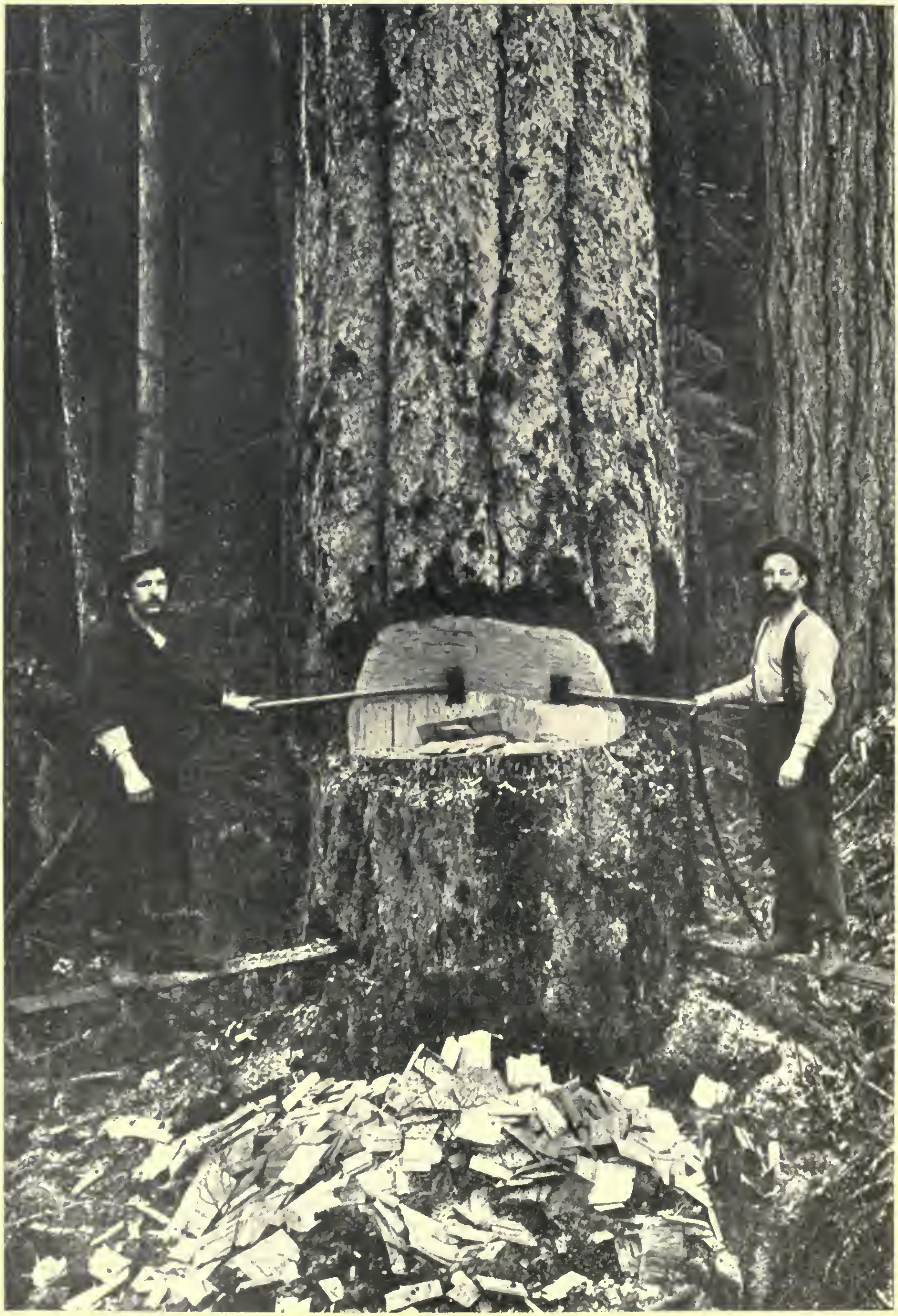
A SCENE IN THE HILLS BEHIND PORT ANGELES, WASHINGTON

MONARCHS OF THE FOREST RISING TOWARD THE SKIES

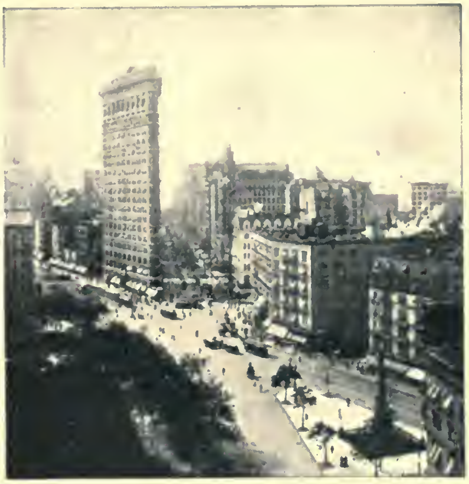


A BIT OF PRIMEVAL FOREST IN CLALLAM COUNTY, WASHINGTON

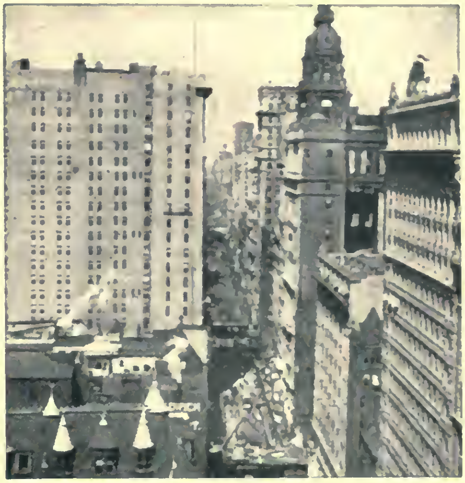
THE GROWTH OF A THOUSAND YEARS COMES TO AN END



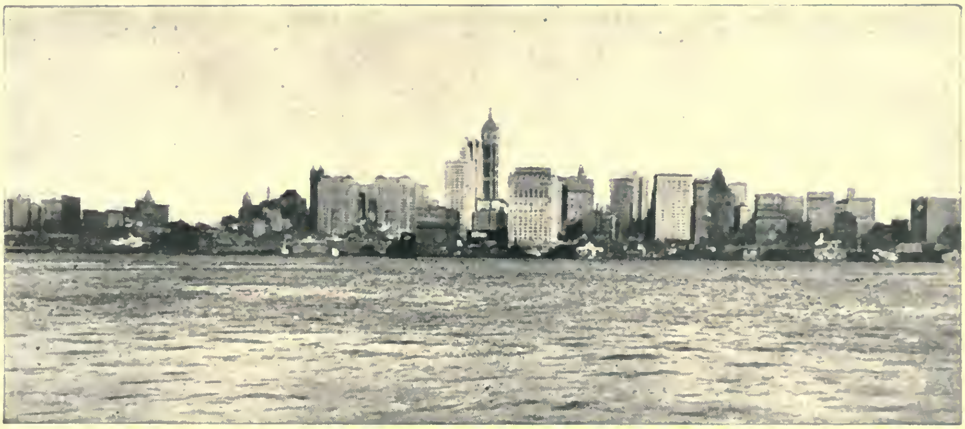
THE AXE AND THE SAW WILL SOON BRING THE FOREST GIANT TO THE GROUND



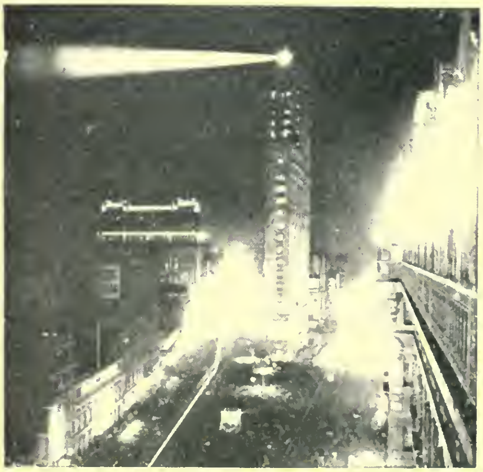
"FLAT-IRON" BUILDING, FIFTH AVENUE



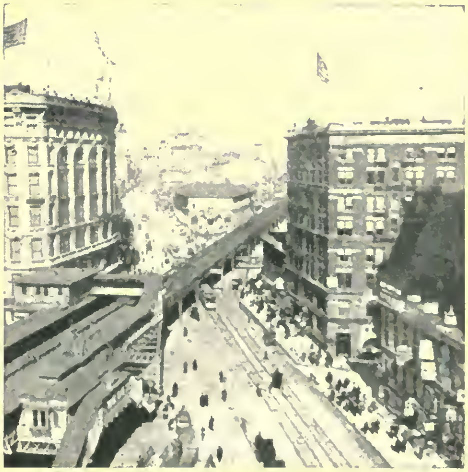
BROADWAY, THE CHIEF THOROUGHFARE



WATER FRONT OF NEW YORK CITY, AS SEEN FROM JERSEY CITY



"TIMES" BUILDING ON AN ELECTION NIGHT



THE FAMOUS "GREAT WHITE WAY"

SCENES IN NEW YORK, THE COMMERCIAL METROPOLIS OF THE UNITED STATES

THE WAY THE WONDERFUL WALL GOES

THE IMPRESSIVE LIAO-HSI MOUNTAINS TRAVERSED BY THE GREAT WALL OF CHINA

CROSSING A FAMOUS BRIDGE ON THE ROUTE OF THE GREAT WALL

These photographs and the wonderful photograph on pages 312 and 313 were taken by Mr. H. G. Ponting, who took the last photographs of Captain Scott's expedition.

THE GREAT CHINESE WONDER

A WALK BY THE GREAT WALL OF 2000 YEARS AGO WHICH KEPT THE ROBBERS OUT OF CHINA

THE GREATEST THING THAT MAN HAS EVER MADE

If we were travelling along the sea-road from Manchuria into China we should have to thread our way among low, rocky hills, where watch-towers and beacons tell of the ancient warfare on the frontier of the empire toward the north.

At length we should notice, rising up against the sky, a hill with three peaks, the tallest peak crowned by a round tower. It stands above a pass through the hills that leads to the border fortress of Ningyuen Chow, which might be called the Chinese Dunbar. After being much shaken by the bumping of a Chinese mule-cart over the rough track through this historic pass, we should see the walls and gate-towers, perhaps also the pink apple blossoms, of the beautiful fortified town.

Here begins the vast plain of Northern China, one of the widest stretches of farm land to be found on the surface of the earth. But in this part, and for miles before us, it is just a narrow, broken ledge along the shore. Treeless mountains tower up on our right hand; the blue waves of the Gulf of Pechili murmur softly on the marshy sand beach to our left. In winter the landscape is a dreary stretch of sand and rock and mud, but in spring it is all beauty, with fruit blossoms and thriving crops and quaint old temples, like those we know in the willow-pattern plate, while the brown-grey mountains and the blue sea make a contrast with the almost endless green.

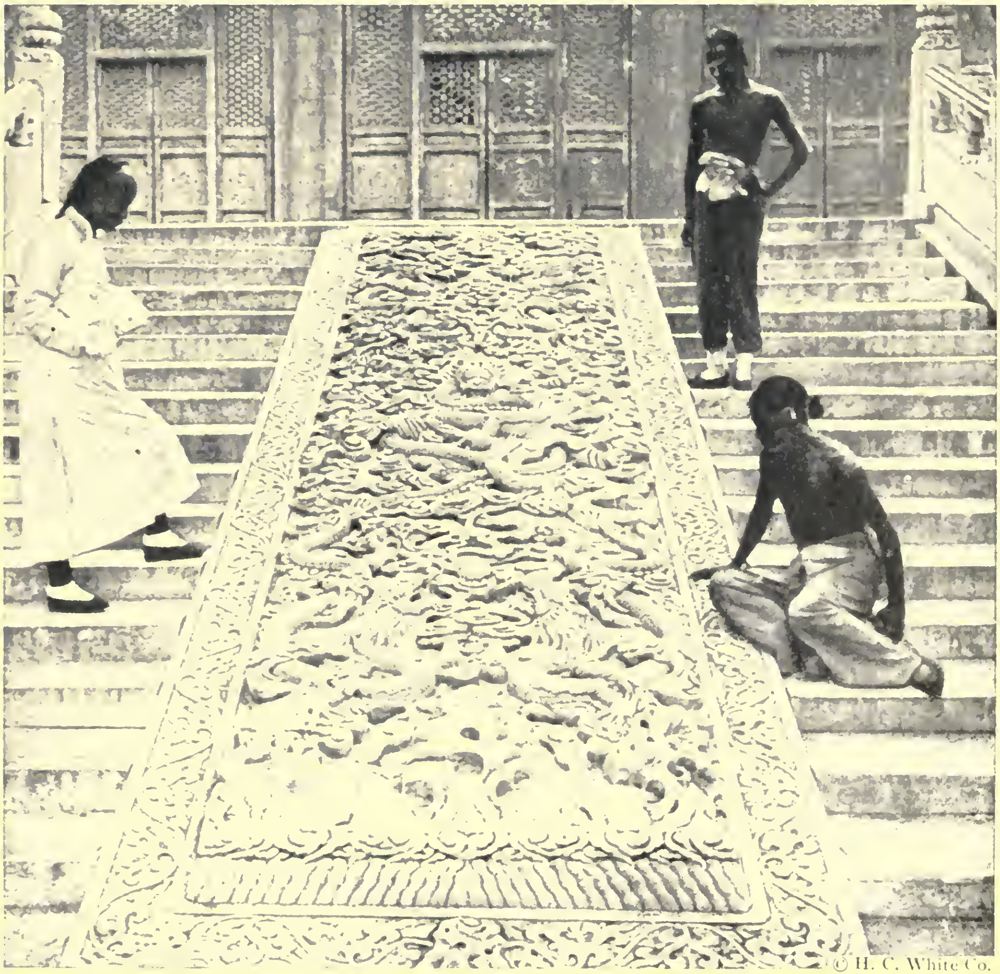
Little by little the plain broadens out in front of us, and the deeply rutted road is further away both from the mountains and the sea. By the time they are each about two and a half miles off, we see, stretching before us, a long, broken line of battlemented wall. It goes the whole way from the shallow gulf to the mountain-top, but we see it only here and there. It is the Great Wall of China, the only building raised by man that is big enough to show on the map of the world. Nearly 200 years ago Dr. Johnson said that if anyone had seen it his grandchildren might boast that he had done so, but many Europeans have been there since his days.

Built about two centuries before the birth of Christ, it was an effort by a people who never liked fighting to protect themselves against restless tribes with no other belongings than their arms and their flocks. The Tartars were wild men, dwelling among the mountains of the north. They lived on their flocks and herds, like Abraham and Lot. They made constant raids on the land of the Chinese, and laughed at them for feeding off the top of a weed, as the Tartars called any kind of grain.

To our left the wall runs out into the blue waters of the Gulf of Pechili; it crosses the plain in front, it rises up the steep hillside, over lofty mountain and into lowest valley, and over desert and field it goes on for about 1500 miles, until it gets lost amid Central Asian sands. There is nothing else at all like it on the surface of the earth.

It was built by Ch'in Shih Hwangti, Ch'in being "the first ruler of mankind." He called himself by that high-sounding name because he pretended that he was the first Emperor of China, and did not want anyone to know that there had been any Chinese people before him, though, of course, there had been millions, and one of them was no smaller a man than Confucius, the great teacher. The vain emperor, seeking to destroy the past, burned all the books he could find, so that no one would be able to read about earlier times, and he killed many learned men; but it was all no good, for when he was dead an old man was found who could repeat the Chinese books from memory, and copies were found in an old house that was being pulled down.

The first emperor laid down better roads, so that he could send his soldiers about and make the people do as they were told; to increase his own power he also did away with many tiresome performances at court; and so that he might be without rivals he made an end of the old Chinese House of Lords. Before his day so much of the emperor's time was taken up with receiving people in robes of many-coloured silk, with peacock feathers and large red and blue buttons, and so much effort was wasted in long processions to temples and back again to the palace, that he really could do very little else. It was towards the end of his reign that he built the Great Wall to give the empire peace from robbers in the cold north.

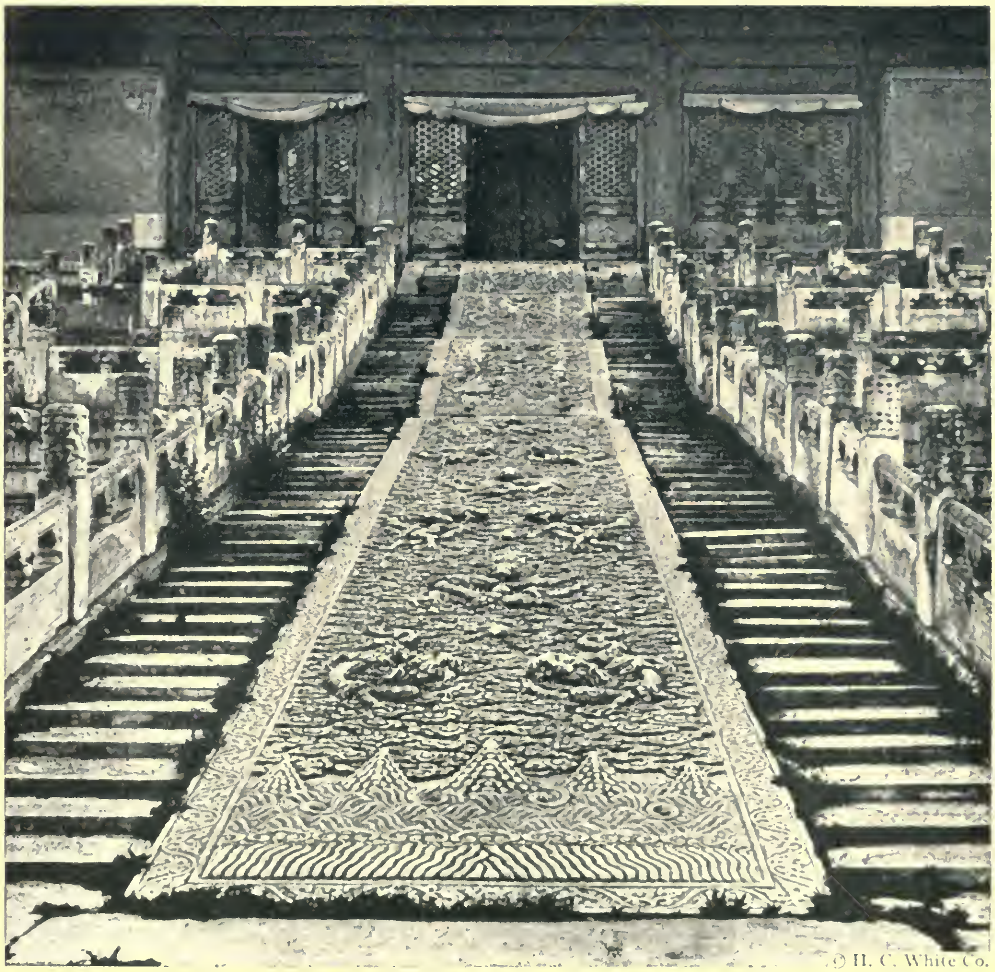


© H. C. White Co.

A CLOSE VIEW OF PART OF A DRAGON STAIRCASE AT PEKIN

At a spot where grass and wild flowers extend to the very border of the sea, three large temples stand. Chinese temples are very numerous and all very much the same. Timbered cloisters and halls stand round square open courts, in which fir-trees of different kinds are planted, producing solemn vistas of dark shade, and sometimes there are little ponds full of lotus plants, with large, smooth, flat leaves on the very surface of the water, and the loveliest flowers like big purple water-lilies rising above them. When the wind comes there is a tinkling ting-a-ring in the air, as little bells under the eaves get blown about; and many temples have two low towers near the entrance, in one of which is a large bell and in the other a large drum. One of these temples has a big figure of Buddha sitting serenely in a huge gilt lotus flower, under a painted roof from which hang curtains and banners of silk, curious lamps, and a well-made model of a junk, or sailing ship.

Close by the temples a breakwater runs out into the waves. It is built of large granite blocks, bound together with iron, quarried from the rocks close by. This is the very beginning of the Great Wall, which starts by taking an irregular curve and then returning once more to the sea, as if hesitating to set out on its long, long journey to the Central Asian sands. At the point where the wall returns to the sea stands a great tower on the shore, a landmark for tall ships. The wall is perhaps 25 feet thick at most, but it varies at different parts. The whole inside is earth; there is brick on each side, and brick paving along the top, so that no one would guess what the middle part was made of if the whole structure were not much tumbled-down. The bricks are very large, and bluish-grey in colour, quite unlike bricks that we know in America.

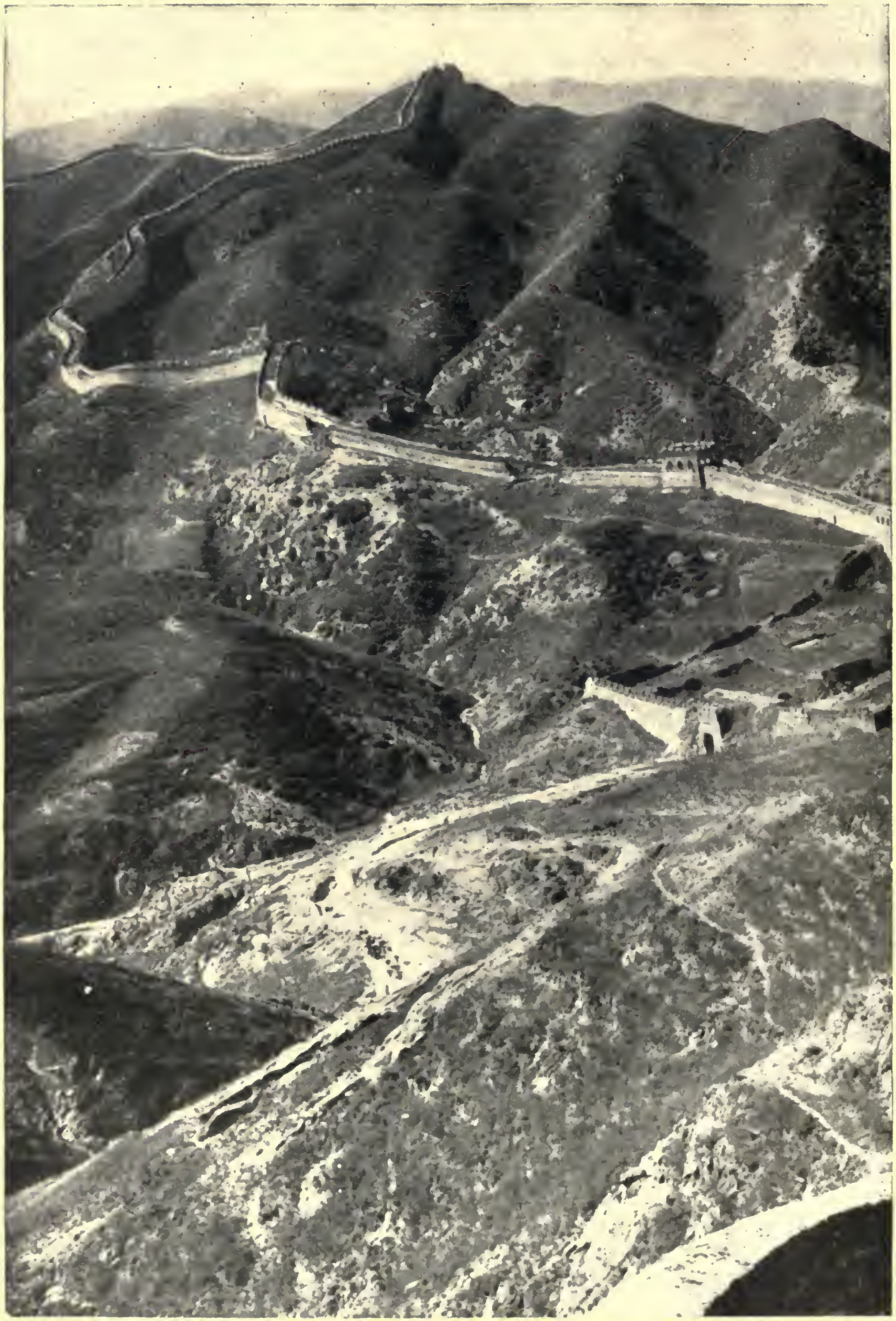


© H. C. White Co.

THE FULL LENGTH OF THE DRAGON STAIRCASE AT THE IMPERIAL PALACE, PEKIN

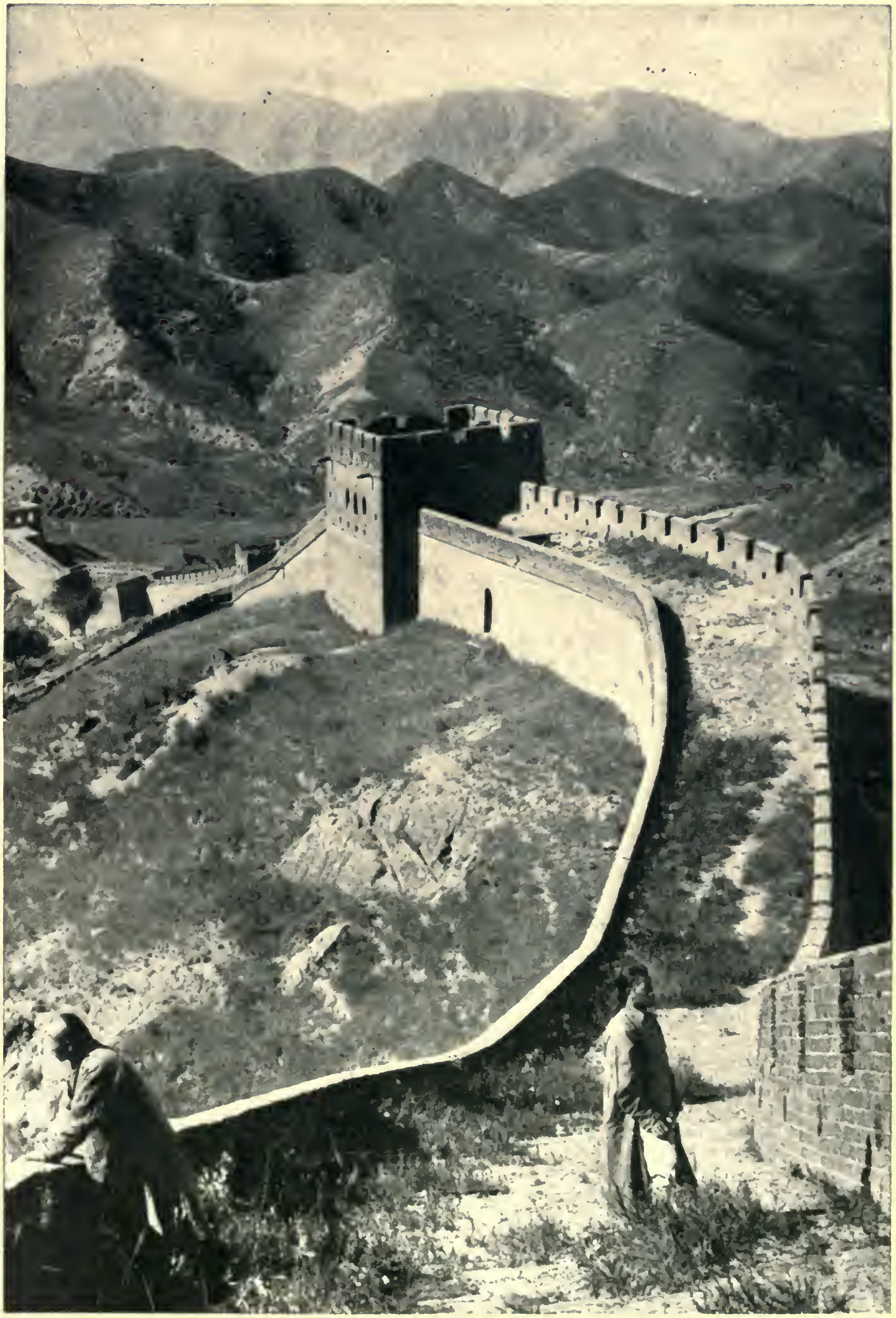
There were once some silk stockings that were so often mended with wool that they soon became worsted stockings. Something of that kind has happened to the Great Wall. It has been so frequently repaired and renewed, patched and rebuilt, that there is very little, or nothing, left that was really the work of the great emperor of the House of Ch'in. Most of what stands was raised by the later emperors of the House of Ming, who, about the time of Oliver Cromwell, did much to repair the wall in the hope of keeping out the Manchu Tartars. The Manchus, however, did get in, and they ruled China till a few years ago. The word Ming means "glorious," and the Chinese sign that represents it consists of the sun and moon together. The Mings were the last native family of emperors who ruled over China. On the top of the Great Wall and on

THE ONLY WORK SET UP BY MEN'S HANDS



IT HAS BEEN SAID THAT THE GREAT WALL OF CHINA, SET UP FOR ABOUT 1400 MILES 200 YEARS BEFORE THE BIRTH OF CHRIST, IS THE ONLY STRUCTURE BUILT BY MEN WHICH COULD BE SEEN FROM MARS

THAT COULD BE SEEN FROM ANOTHER WORLD



THIS MIGHTY WALL OF BRICK AND STONE, 25 FEET WIDE, WINDS ITS WAY ACROSS MOUNTAINS AND PLAINS, BEARING WATCH-TOWERS UP TO GREAT HEIGHTS, FROM WHICH IN OLDEN TIMES THE GUARDIANS OF THE EMPIRE LOOKED OUT FOR ADVANCING ROBBERS the walls of the cities near by, lie a number of very ancient guns, some made of brass, but most of them of iron. The Chinese knew about gunpowder many centuries before the Europeans, but they never understood how much could be done with it. Their old guns can do no more than send a cannon ball without much aim for a few hundred yards, and even so they are apt to be more dangerous on the whole to their own gunners than to the enemy against whom they are fired. To load them takes so long that there would almost be time to repair any damage they did before another shot could be fired. Some are actually built into the wall, so that they cannot be aimed at all, and if there were to be any serious chance of the enemy being hit, he would have to be told just where to stand, as if he were posing for a photograph. This may help us to understand the chief difference between our history and the history of China. We know that the first beginnings of new inventions are of but little use. The first motor-cars and flying machines that were made were no more than very dangerous toys, and such things are only useful after many years of work in improving them.

A CHINESE DOORWAY © H. C. White Co.

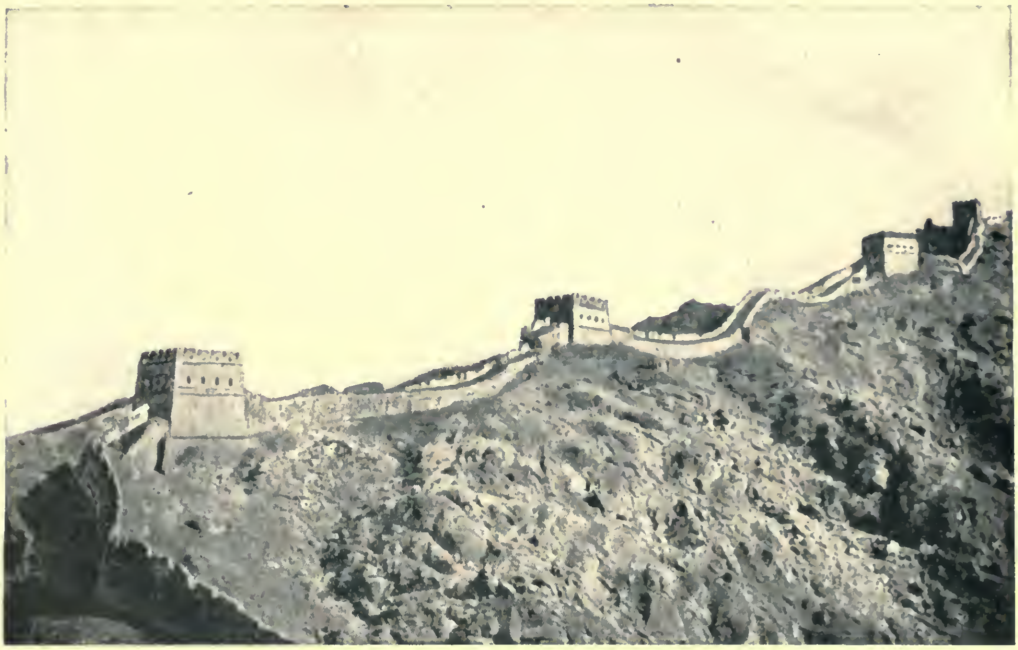
In Asia new inventions have nearly always been kept as they were first made, largely from a sort of feeling that it would be rude to their inventors to alter the plans. A rather foolish examination question once asked what part in present-day politics King Alfred would be likely to take supposing he were still alive. It was answered by a bright child—much better than it really deserved—that if King Alfred were still alive he would be far too old to take *any* part in present-day affairs. The question was absurd, because our ways of life change so fast that no one really knows what part anyone would have taken had he lived at another time. He would really be a different person. But in China such a question would not have been foolish, for, until Europeans came, the life of the people had remained the same for many centuries.

What is true of gunpowder is as true in different ways of printing and the sailor's compass. The Chinese knew of printing five hundred years before we did, and of the compass even longer, but neither invention was ever made more perfect, so that they brought very little difference to the life of the people.

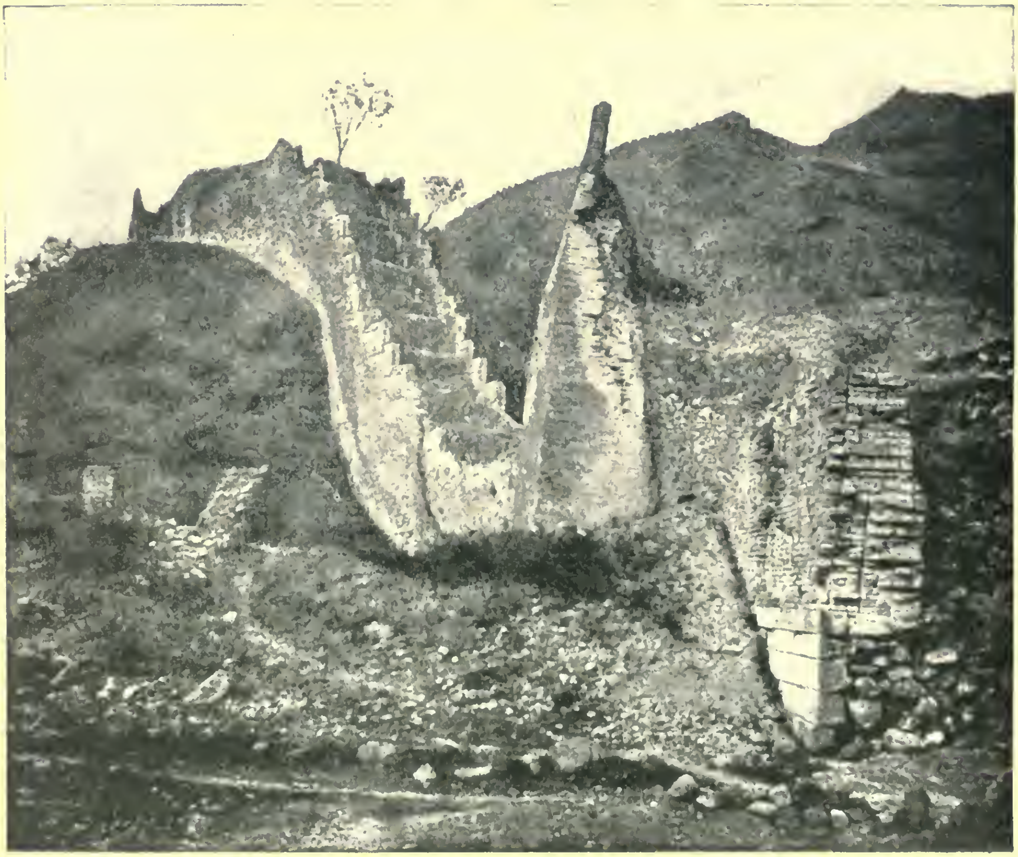
Half-way across the plain one of the many rivers that start from the hills has washed away parts of the Great Wall, and through the gap thus made passes the earliest of Chinese railroads, on its way from Pekin to Newchwang, or "Bullock Town," a well-known Manchurian port. Now that it is finished, we might go through the pass by Ning-yuen Chow in a railway carriage instead of in a jolting mule-cart. It is strange to see the funny pictures of engines that Chinese boys sometimes drew on the white walls with bits of charcoal.

On its way from Pekin the line passes Tong Shan, where, in a region of little hills with temples on the top of them, is the first coal-mine in China to be worked by European methods, though the Chinese knew about coal long before white men came to their country. This is what Marco Polo, the explorer who spent some time in China during the thirteenth century, has to say about it—evidently he had not seen coal in Europe—"There is found a sort of black stone which they dig out of mountains, where it runs in veins. When lighted it burns like charcoal, and retains

THE HUGE WALL THAT CREEPS ROUND CHINA



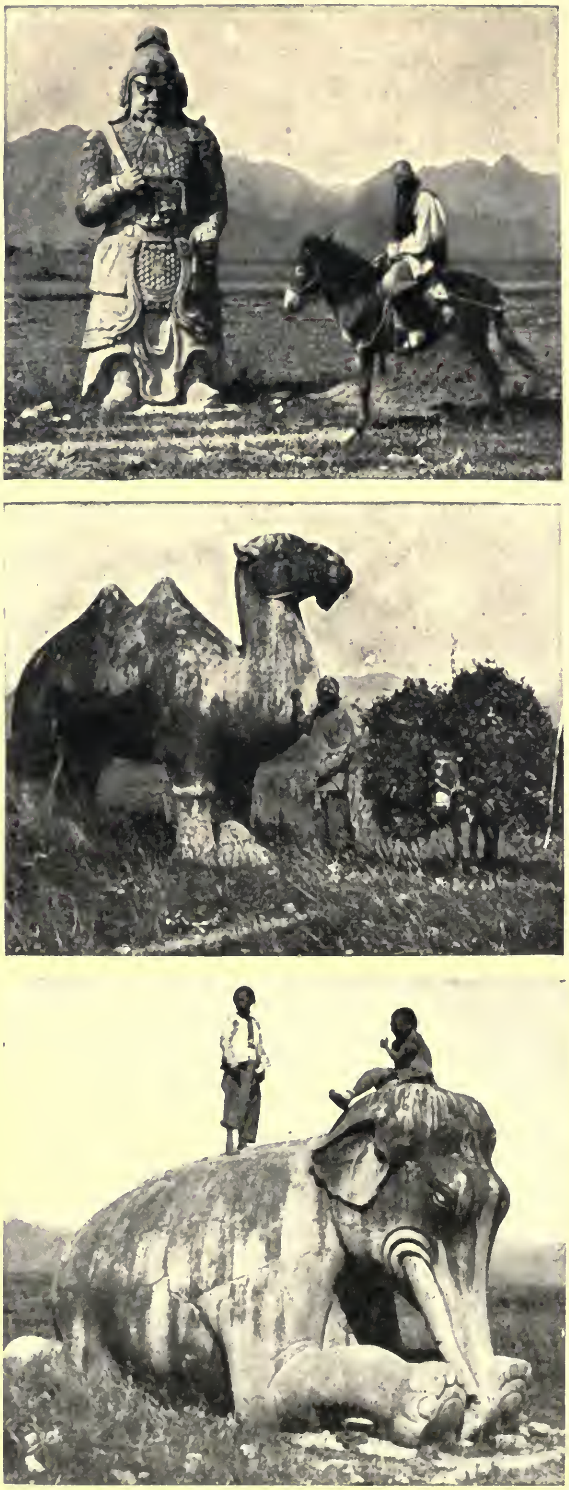
HOW THE GREAT WALL FOLLOWS THE NATURAL CONTOUR OF THE LAND



THE EXTRAORDINARY UPS AND DOWNS OF THE GREAT WALL the fire much better than wood, insomuch that it may be preserved during the night, and in the morning be found still burning. These stones do not flame, excepting a little when first lighted, but during their ignition give out a considerable heat."

Just beyond where the railway crosses the Great Wall, the wall is joined by the city wall of Shan Hai Kwan. Few towns on earth are more magnificently placed, and the situation is expressed by the name, which means the border between the mountains and the sea. The city walls join the Great Wall, and are so ruinous and overgrown with grass that ponies feed upon them.

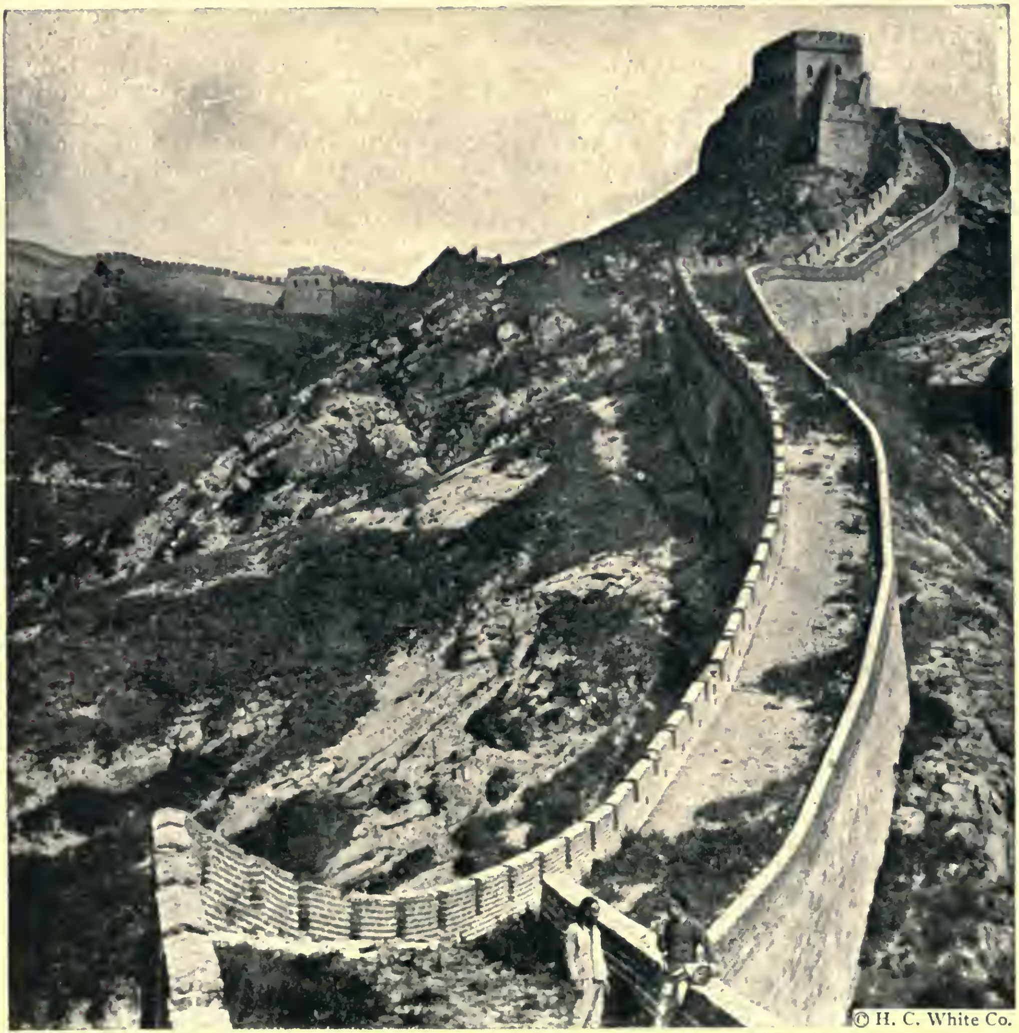
The effort to wall in the empire itself was just what might have been expected from the Chinese. They like to have everything walled—their towns, their houses, and even their gardens—so that no one can see in; and all their windows open to inside courts so that no one can see out. They do this because they object to people knowing what they are doing when they are at home. Sometimes the walls of the cities prove useful in keeping out wild animals. From the soldier's point of view the Great Wall can hardly be called a success. A great deal of work was wasted in carrying it up steep mountain-sides where no enemy could climb to attack. It is by no means so good a fortification as the much shorter wall that the Romans drew across the north of Britain from the neighbourhood of Carlisle to the place still known as Wallsend, close to Newcastle-on-the-Tyne. The Romans were good soldiers, and the Chinese are not; but the Chinese began to rule the eastern part of Asia before Rome was built, and China is still in existence centuries after the Roman Empire has passed away. The Chinese say that you don't make a really good piece of iron into a nail, neither do you make a good man into a soldier. The first person we hear of who became emperor by his own works had become known, not by fighting, but by banking up the



STRANGE FIGURES NEAR THE GREAT WALL—STATUES FROM THE AVENUE OF STONE ANIMALS AT THE MING TOMBS

© H. C. White Co.

THE OLD AND THE NEW IN ANCIENT CHINA


© H. C. White Co.

AN ANCIENT WATCH-TOWER ON THE GREAT WALL OF CHINA

A CHINESE TRAIN PASSING THROUGH THE WALL OF PEKIN sides of the Yellow River, and so saving the great plain from floods.

The wall has never defended China from an enemy able to hope for the conquest of the empire as a whole, or even of the northern part, but it has shielded the Chinese from many robbers who merely wanted to raid farm or town, then to return to their mountains.

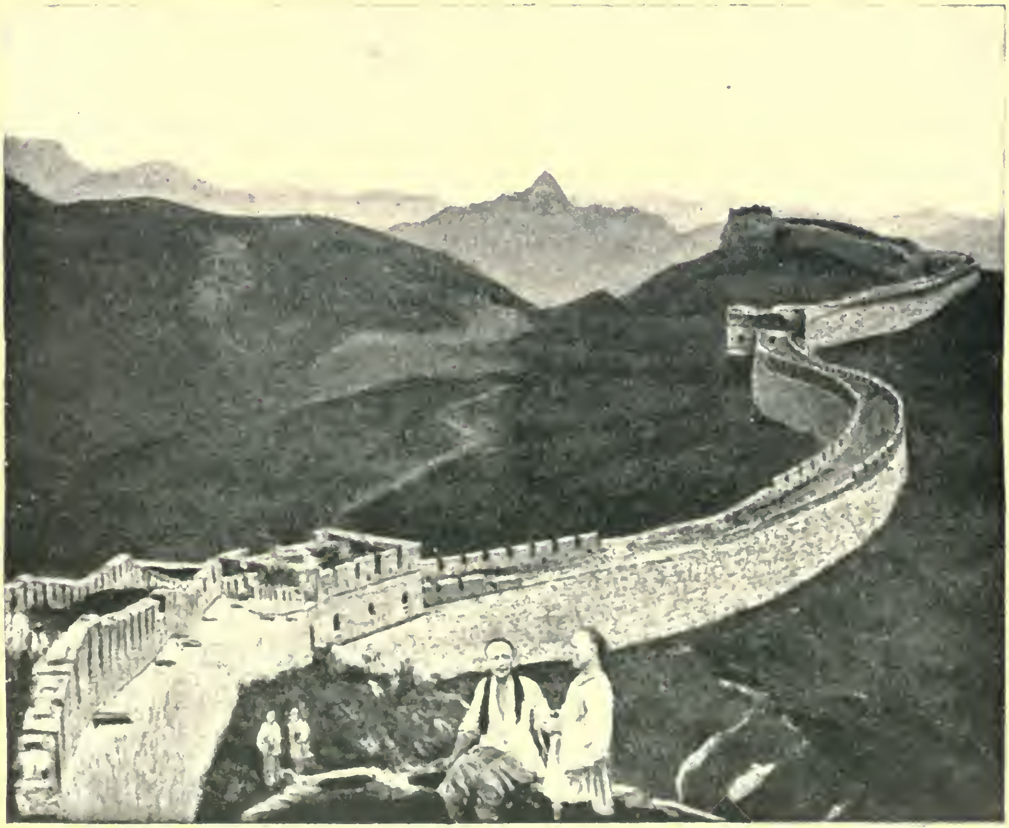
THE GUARD HOUSE OF A CITY NEAR THE GREAT WALL © H. C. White Co.

The only gate in the wall between the mountains and the sea opens to the city of Shan Hai Kwan; the ancient road passes through. Two or three miles away begins the difficult path up the mountain-side. There is here no earth inside the wall, and the rows of bricks oddly slope up with the slope of the hill, so that in parts it almost looks as if the whole thing might slide right down, if it were not supported by the numerous towers that stand upon ledges of rock. The brickwork here as in the plain, is very much broken down, and wild flowers grow as plentifully in the cracks of the wall as they grow between the rocks. Some of the flowers on the wall grow only in gardens with us, such as pink begonia, and tall purple irises, and a kind of Canterbury bell, but there is also a small orchid, and much the commonest thing is a beautiful little pink that grows wild in America too.

We cannot go up over the mountain along the top of the Great Wall. Before we are half-way up we find the wall stopping against a huge cliff of rock, and high above is a huge tower from which it starts again. Nothing would have been easier than to carve steps in the rock, but the thing was never done, and in order to get any higher we must come down a long way before we can get from the top of the wall to the surface of the ground. Then we must scramble up the rocks as best we can, and get on to the wall once more above the tower.

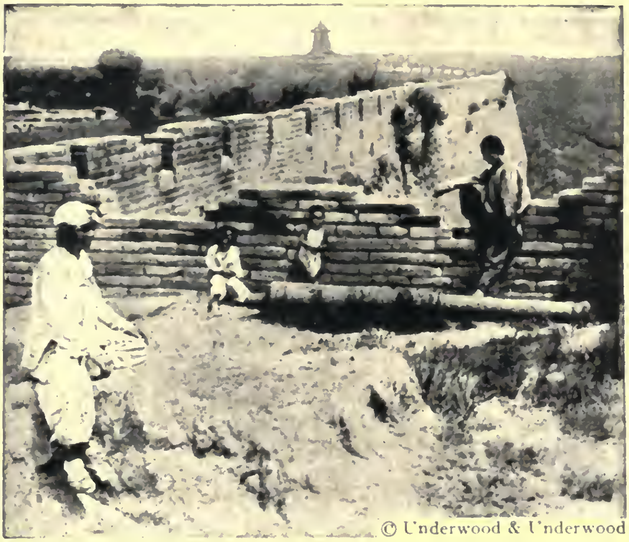
HOW THE GREAT WALL CLIMBS THE MOUNTAINS

THE REMARKABLE PRESERVATION OF THE FORTIFICATIONS OF THE GREAT WALL



THE GREAT WALL WINDS ITS WAY OVER THE MOUNTAIN-TOPS

As we have been climbing we have been able to look further and further across the plain and the sea; when at last, after several hours, we stand by the wall near the mountain-top, we have before us one of the finest views on the earth. Around us is a wilderness of rough rock without a single tree. Big towers rise on each lofty peak, out where the enemy would be. We almost seem to see the ancient watchers of the empire anxiously looking towards the north to see if robbers were in view. Far below, stretching widely, is the green plain, farmed as only the Chinese can farm, their endless little fields making it look like a huge patchwork quilt.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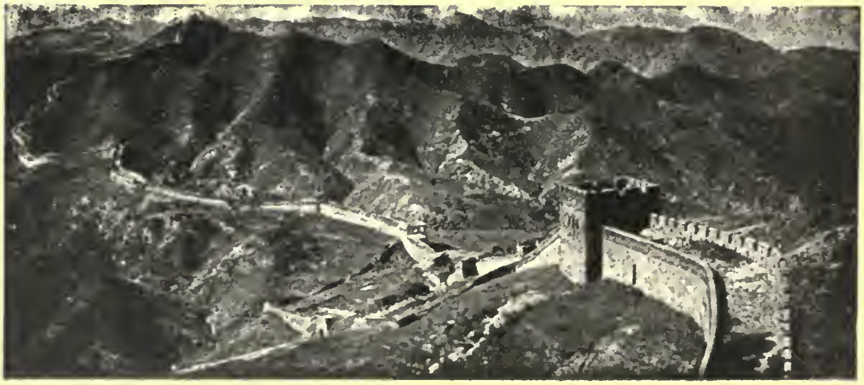
REPAIRING THE GREAT WALL 2000 YEARS AFTER BUILDING

Away to the right, by those little rocky mounds that are known as the Lotus Hills, is the seaside resort of Pei Tai Ho, well known to all Europeans who live in Northern China. Bungalow houses with gardens are scattered up and down by the shore, but there are no streets, no asphalt, and no brick pavements. English children paddle on the sand or bathe in the sea, where tiny waves ripple over seaweed-covered rocks, and grass and flowers still come up to the very edge of the Pacific.

Below us, in front, is the strongest gateway of China. The Manchus, who ruled the empire till a few years ago, broke through the wall by desert paths inland in the neighbourhood of Pekin, but not till the Chinese commander, despairing of his country, went over to their side did they make their way through the strong city of Shan Hai Kwan. And where their army at last marched in, we see the smoke of railway trains today.

The Great Wall up which we have come winds down the mountainside and over the plain to the blue sea beyond, and where in ancient days the water was only dotted by the brown and white sails of Chinese junks, we see now the funnels of steamers from many parts of the world.

For ages the Chinese kept out foreigners. They did not want to learn what other countries had to teach, and so they built around themselves a wall of law and custom, through which it has taken many years to make a way. But at last, this wall too has broken down. The whole nation is waking up, and many Chinese students come to our schools and colleges to learn what we have to teach.



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